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MICHIGAN ACADEMY OF SCIENCE  
ARTS AND LETTERS

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VOLUME XXV (1939)

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MEETING IN 1939

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VOLUME XXV CONSISTS OF FOUR PARTS

PART I BOTANY AND FORESTRY

PART II ZOÖLOGY

PART III GEOGRAPHY AND GEOLOGY

PART IV GENERAL SECTION

ANTHROPOLOGY

LANGUAGE AND LITERATURE

PSYCHOLOGY, SOCIOLOGY



PAPERS OF THE  
MICHIGAN ACADEMY OF SCIENCE  
ARTS AND LETTERS

EDITORS

EUGENE S McCARTNEY  
UNIVERSITY OF MICHIGAN

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UNIVERSITY OF MICHIGAN

VOLUME XXV (1939)  
IN FOUR PARTS

"Pusilla res mundus est nisi in illo  
quod quaerat omnis mundus habeat."

— SENECA, *Naturales Quaestiones*

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## **BOTANY**





SUMATRAN PALMS I

CALAMOXLEYA, A SUBGENUS OF CALAMUS  
TYPIFIED BY *C LEIOSPATHUS*, A NEW  
SPECIES RELATED TO *C OXLEYANUS* \*

HARLEY HARRIS BARTLETT

**F**ROM a practical standpoint so immense and highly diversified a genus as *Calamus* might well be divided if it were possible to segregate clearly natural genera of more than a single or a few species. The immediately segregable elements, however, if removed, would hardly leave the residual genus less cumbersome. Consequently it is better to attempt to define groups tentatively, as subgenera within *Calamus*, which, if they stand the test of time as distinct and logical assemblages, may eventually, perhaps, be considered worthy of generic status.

Before *Calamus* in the broad sense can be reviewed much more thoroughly than it was by Beccari, intensive collecting must be done through almost the entire range of the genus. During the last few years the careful collecting of a native Sumatran, Rahmat Si Boeaja, has brought about the accumulation, in the University of Michigan Herbarium, of an unusually adequate suite of Sumatran palms, including *Calami* and other rotans, from the Batak lands and the East Coast.

At the present time many undoubtedly valid palm species are known from material so defective that it is impossible to place them with their natural associates on the basis of the characteristics that must be used for establishing either subgenera or genera. The herbarium specimens are so insufficient, sometimes only male, sometimes only female, sometimes lacking leaves or sheaths, or other essential parts, that certain species have to be placed by guess as

\* Papers from the Department of Botany and the Botanical Gardens of the University of Michigan, No 691

Calami even in the present broadly inclusive sense. One obvious advantage of first proposing as subgenera subdivisions of the too-inclusive genus is, of course, that no established binomials need be disturbed until reasonable certainty is arrived at regarding the position of most of the species.

In this article the writer proposes *Calamus* subgenus *Calamoxleya* to include climbing palms differing from the great majority of Calami in having strongly cirriferous leaves, nonflagelliferous leaf sheaths, and nonflagelliform inflorescences which, however, arise from and are adnate to the leaf sheaths. In this assemblage of characteristics subgenus *Calamoxleya* resembles *Daemonorops*. That its retention in *Calamus sens lat* is not irrational is immediately indicated by the tubular persistent spathes and by the subuncinate spines of the inflorescence, the latter providing a point of slight resemblance to those Calami which show all gradations between a strongly clawed sheath flagellum and an inflorescence practically always flagelliform in its terminal part. Subgenus *Calamoxleya* has as the terminal portion of the inflorescence a vestigial sterile structure (*caudicula*), which is short and remarkable for its subinflated sheaths, not at all for any resemblance to the typical clawed flagellum of most Calami, for it has no united "hands" of retrorse claws. The sparse thorns are solitary and, if only vaguely uncinatate, at least not quite straight.

A difference between subgenus *Calamoxleya* and the vast majority of Calami and *Daemonorops* is that the leaves of mature, flowering specimens lack or only vaguely suggest the usually pronounced gibbosity of the leaf sheath below the insertion of the petiole. There are a few aberrant species in *Daemonorops* that have nongibbous sheaths, but, so far as I know, there exist no climbing Calami with nongibbous sheaths, with the exception of *Calamus Oxleyanus* Trcysm & Binnend ex Miquel<sup>1</sup> and the new *Calamus leiospathus*, which is to be considered the type species of subgenus *Calamoxleya*. The nongibbous leaf sheath is found in genera allied to *Calamus*, such as *Plectocomia*, *Plectocomiopsis*, and *Myrialepis*. It is to be noted that *C. Oxleyanus* is described as erect when young and as climbing in age, and that those species of *Daemonorops* with nongibbous sheaths are also described as nonscandent.

<sup>1</sup> Miquel, F. A. Guil, *De palmis Archipelagi Indici observationes novae* Amstelodami apud C. G. Van der Post, 1868.

In general, the Calami and the Daemonoropes show a very interesting negative correlation with regard to flagellum and cirrhus. If the leaves terminate in a clawed cirrhus, the inflorescence has no flagelliform, clawed, sterile appendage, and the sheaths are not flagelliferous. (In Calamus the flagella are, morphologically, sterile inflorescences, and all degrees of sterilization are to be found. Both flagella and inflorescences arise from and are adnate above to the outside of the leaf sheath.) On the contrary, if sheath flagella and the morphologically equivalent flagelliferous inflorescences are found, the clawed cirrhus is usually missing or vestigial. Only in exceptional species is it well developed. In *C. Oxleyanus* the similarity in vegetative structures to Daemonorops is so great that one might easily put this species in the latter genus (as Martius, in fact, did) if the inflorescence were unknown. Inclining in vegetative morphology to Daemonorops, but in more fundamental characteristics to Calamus, the new subgenus Calamoxleya superficially resembles Plectocomiopsis and certain other genera of that alliance in its nongibbous sheaths. The latter genera, however, do not have the inflorescence adnate to the outside of, and arising from, the leaf sheath. What has only been inferred in the past is now known by the argument of analogy with the obviously very closely related new species *C. leiospathus*, namely, that the inflorescence is adnate to the leaf sheath in *C. Oxleyanus*, and that the species is therefore actually closer to Calamus than to genera with axillary or terminal inflorescences. Such evidence, previously only assumed (perhaps because the species is cultivated at Buitenzorg, where it has flowered and where herbarium specimens have been made with no note of the inflorescence being borne otherwise than is usual in Calamus), is now at hand in *C. leiospathus* from Sumatra. It is curious that descriptions have not been clear respecting this point, for Griffith,<sup>1</sup> Miquel (*loc. cit.*), and Beccari,<sup>2</sup> making no statement at all, have left the reader to assume what now proves to be the truth. Miquel's plate is entirely ambiguous, not showing the origin of the inflorescence except in the

<sup>1</sup> Griffith, Wm, *Palms of British East India*. Calcutta printed by Charles A. Serrao, 1850. This important folio volume is a part of the "Posthumous Papers bequeathed to the Honorable the East India Company and printed by Order of the Government of Bengal."

<sup>2</sup> Beccari, Odoardo, "Asiatic Palms — Lepidocarpaceae, Part I. The Species of Calamus," *Ann. Roy. Bot. Gard. Calcutta* (Calcutta: Bengal Secretariat Press, 1908), 11, 113, 114, 450-453; pl. 203.

habit sketch, where, placed by the artist in an impossible situation, the spadix appears to arise from the petiole, not from the sheath

The characteristic chiefly relied upon for the separation of the new Sumatran *C leiospathus* from the original *C Ozleyanus* of Bangka, collected by Teysmann and described by Miquel, is indicated in the name. In the so-called pistillate (actually monoecious) plants the difference between smooth or almost smooth and very thorny spathes appears to be sufficient for a clear separation, but nevertheless of too minor a nature to allow us to believe that in the more important characteristics pertaining to subgenera or genera there can be lack of coincidence between the two species. In Beccari's description there are indications of numerous more obscure differences, which cannot be relied upon because of the distinct possibility that *C Ozleyanus*, as defined by him, includes more than one species. The specimens studied by him were from Malacca, Johore, Singapore, and the Buitenzorg Garden, the latter presumably grown from Teysmann's seeds collected in Bangka. Beccari<sup>4</sup> himself named one element of the possible mixture *Calamus diffusus*, but later reduced it to synonymy. The first specimen ever reported that belonged to the subgenus was found by Griffith's collector, E. Fernandez, in Malacca, about 1844, but because it was sterile Griffith referred to it in his great work on the palms (*op cit*, pp 95-96) only by the Malay name, *rotang pajare*. He had sent it to Martius,<sup>5</sup> however, who rated it as a distinct species the affinity of which could not be made out because of the deficiency of the material, but who named it (presumably in 1848 or 1849) *Daemonorops fasciculatus*. Because of the prior *Calamus fasciculatus* Roxb., Wendland<sup>6</sup> could not recog-

<sup>4</sup> Beccari, Odoardo, "Systematic Enumeration of the Species of *Calamus* and *Daemonorops*, with Diagnoses of New Ones," *Records Bot. Surv. India*, 2: 197-230, 1902. The name *C diffusus* Becc. occurs without description on page 206, with locality Singapore. The later monograph (footnote 3) indicates that this name was applied by Beccari in Hooker's *Flora of British India*, VI: 447, 1894, to a mixture of two presumably unrelated plants collected by Lobb at Singapore, of which the male spadix was the part that Beccari later referred to *C Ozleyanus*. The accompanying foliage had equidistant leaflets, with the costa spinulose below, and may not have belonged with the inflorescence.

<sup>5</sup> Martius, Carol. Fried. Ph., *Historia naturalis palmarum*. Lipsiae, T. O. Weigel. The description of *Daemonorops fasciculatus* occurs among the last sheets published (III. 330) and, therefore, probably dates from 1849, whereas Roxburgh's prior *C fasciculatus* dates from 1832.

<sup>6</sup> Wendland, H., "Index général des noms et synonymes des espèces connues," in Oswald de Kerchove de Denterghem, *Les Palmiers*. Paris, 1878.

nize this name when he transferred the plant to *Calamus*, so he re-named the species *Calamus Fernandezi*. Needless to say, only the study of fertile material from the type locality, matching the type, would justify a botanist in taking up the latter name, based as it was upon sterile material (complete leaves, with sheaths and cirrhi). It is important to note that Martius described it as "*in vaginae ore longe obliqua infraque petiolum gibbosa*". In the material of the new Sumatran *C. leiospathus* it requires some effort of the imagination to detect a gibba on part of the sheaths, and others certainly have no suggestion of one. The gibba is too indistinct at best to be equated with the well-developed structure usually found in *Calamus*.

In view of the facts that the existing materials referred to *C. Oxleyanus* are fragmentary, and perhaps not all conspecific, and that the descriptions are in several important respects too vague, I have had to rely for immediate separation of *C. leiospathus* upon one dependable difference, which, although clearly indicated in the original plate and description of the older species, is not sufficiently supported by other certain differences to make one confident that it is of more than varietal significance. Other contrasting characteristics will doubtless be found, however, when it becomes possible to draw up a comparable description of *C. Oxleyanus*. The Sumatran plant is justifiably proposed as a distinct species from *C. Oxleyanus*, of which the cultivated type was grown from Bangka seeds, because rare and local palms seldom have wide ranges and because it seems absurd to typify the new subgenus *Calamoxleya* (which will doubtless in time be treated as a genus) by fragmentary material when there are well-nigh perfect and complete specimens available (every important part except the petiole) of the somewhat different but clearly related Sumatran plant.

The plates illustrating the descriptions that follow are by Miss Olivia Embrey.

**CALAMUS**, subgen **Calamoxleya**, subgen. nov. — Frondes valde cirriferi. Inflorescentiae vaginis frondium extus adnatae, elongatae, sed non in flagella longa uncifera transeuntes. Flagella sterilia inflorescentiis aequivalentia omnino desunt. Spathae et spathellae tubulosae vel infundibuliformes, persistentes. Involucrum florum femineorum duplex, inferius depresso cupuliforme, ad marginem cicatricem vel cicatrices floris singuli masculi vel florum trium

masculorum ferens, superius vel annuliforme, varie lobatum, vel triangulum vel linguiforme (interdum apice bipartitum) vel fere obsoletum Endosperma alveolatum, album, homogeneous Embryo et fovea raphialis exacte opposita Species duae typica *C leiopathus*, sp nov (vide infra), altera *C Oxleyanus* Teysm & Binend ex Miquel, *De palmis Archipelagi Indici observationes novae*, pp 17-18, tabb A et B 1868

**Calamus** (*Calamoxleya*) *leiopathus*, sp nov — Caulis verisimiliter scandens, vaginatus 2-2.5 cm crassus Vaginae. (v Tab I, Fig 1) colore ferrugineae vel cinnamomeae, horride spinosae, sed infra petioli insertionem in area angusta ex petioli dorso producta laeves, espinosae, omnino vel paene ebullatae, ore longe obliquae, sine ochrea Spinae longitudine valde variantes, vel breves vel usque ad 4 cm longae, ad basin cum vaginis concolores, sursum lucide griseae, omnes subulatae, laminares, flexiles, inordinatae vel obscure seriatae Petiolus in speciminibus omnibus deest Frondis pars foliolifera ca 2.25 m longa, in cirrho robusto uncifero (v Tab I, Fig 3) terminali 80-100 cm longo desinens Foliola (infimo et 2 vel 3 supremis exceptis) in gregibus foliolorum 4-10 propinquorum (intervallatis secus idem latus 10-35 cm distantibus) alternate vel subopposite disposita Foliolum infimum solitarium ca 160 mm longum, 11 mm latum Grex inferior 3-foliolatus, foliolis inter se ca 9 cm distantibus, ca 250 mm longis, 16 mm latis, medius ca 7-foliolatus foliolis 250-300 mm longis, 17-18 mm latis, inter se ca 12 mm distantibus, supremus ca 5-foliolatus, foliolis ca 220 mm longis, 14-15 mm latis, inter se ca 24 mm distantibus, a 2 vel 3 foliolis solitariis minoribus longe distantibus secutus Foliola omnia acuminata apice attenuata et in spinula ca 4 mm longa desinentia, spinulis prope folioli apicem marginalibus 2-4 mm longis, propinquis, plerumque binis, castaneis, deorsum sparsioribus, brevioribus ad folioli marginem appressis apice castaneis basi albidis et ex insertione albida cartilaginea orientibus, venis pagina inferiore omnibus laevibus, pagina superiore 3 ex eis spinulosis, vena media sparse, spinulis distantibus, ca 3 mm. longis, 2 venis lateralibus densius, spinulis ca 3.5 mm longis (v Tab I, Fig. 2) Rhachis parte inferiore (prope petioli apicem) subtus convexus spinas duras subflavidas triseriata ferens, eas in serie mediana solitarias unciformes, eas in seriebus 2 sublateralibus longitudine variables rectiusculas paululum deflexas vel paene subunciformes, supra laevis espinosus

subconvexus, *parte media* subtus convexus spinas omnes unciformes ferens, eas serici medianae singulas vel binas, eas laterales singulas, supra angustissime applanatus laevis pro lateribus obliquis atque foliorum insertione, *parte superiore* (prope foliola superiora) subtus angulatus unguiculatus spinis medianis binis vel ternis vel quaternis basi flavidis apice atris, spinis paucis lateralibus solitariis debilioribus quam eis aggregatis. Cirrhus 80-100 cm longus modice robustus unguiculatus spinis medianis plerumque ternis vel quaternis, basi turgidis flavidis sursum gracilibus, fuscis. Spadix monoecius (ut dicitur "femineus") ex folii vagina oriens ca 1 m longus, partibus inter spathas nudis plus minusve armatis, spinis solitariis vel binis vel ternis, lateraliter compositis, retrorsis vel unciformibus, basi percurrentibus, tumidis, flavidis, ferens ramos primarios ca 5 singulatum ex spathae ore obliquo paulo infra apicem haud ex basi orientes, desinens in caudicula brevi spathas 2 vacuas subinflatas ferente (v. Tab II, Figg 5-6) rhachi inter spathas caudiculae spinis 2 vel 3 solitariis rectiusculis vel retrorsis praedita, spatha suprema terminali. Spathae primariae (v. Tab II, Fig 4) tubulosae, 10-18 cm longae ore longe obliquae sursum carinatae, apice acutae vel obtusiusculae, alte angulatae minute furfuraceae, aut plerumque inermes aut interdum parvisime armatae, spinis brevibus retrorsis, basi flavidis, apice fuscis. Spadicis monoecii vel "feminei" rami ca 30 cm longi, spiculae ca 12 distichas 4-13 cm longas ferentes ex oribus spatharum secundarum, spathis secundariis primariis similibus, inermibus, ad apicem versus paulum expansis, ore longe obliquis. Spiculae ex ore spatharum haud ex basi orientes, axillis molliter parenchymatosi verisimiliter nectariferis, spathellis latere vacuo ad rhachin appressis, latere florifero valde producto expansis obtuse apiculatis. Involucrophorum cartilagineum, depresso cupuliforme una sola puncta in apiculum obtusissimum vix obvium productum. Involucrum cartilagineum duplex, membro inferiore (involucro proprio) cupuliformi extus ad marginem incrassatum inter apiculos duos obtusissimos ferente areolam sublunatam includentem floris masculi (ut dicitur "sterilis") cicatricem, membro superiore in spicae parte ultima plerumque fere nullo, in parte media asymmetricè annuliformi vel triangulo, in spicae parte proxima valde conspicuo vel annuliformi vel triangulo vel linguiformi ad involucri proprii marginem attingente et latitudine cicatricem floris feminei vel "fertilis" aequante (v. Tab III, Fig 7). Perianthium basi pedicelliforme (v. Tab III, Fig 11a)



segmentis exterioribus incrassatis tertia vel dimidia parte sursum plerumque duplo vel triplo dilaceratis, ca 3 mm longis,  $2\frac{1}{2}$  mm latis, intus laevibus, extus solum aetate versus apicem 10- vel 12-venosis, segmentis interioribus haud venosis, quarta vel tertia parte connatis, 3 mm longis,  $1\frac{1}{2}$  mm latis, margine integris, apice acutis. Staminodia basi connata cupulam 6-apiculatam formantia (v Tab III, Fig 11b) apicibus quam sepalis brevioribus, angustatis, truncatis, sinibus latis nec profundis, semiellipticis. Fructus immaturi valide mucronati, lepidibus circumundique 12-seriatis, stramineis, nitidis, latioribus quam longioribus, obscurissime canaliculatis, margine brunneo excepto concoloribus. Flores ex involucri latere masculi (nec, ut dicitur "steriles") ante anthesin 5 mm longi anguste cylindrici, calyce distincte nervoso vix alabastrum mediam attingente, apice obtuse leviterque tridentato, deinde (flore aperto) profundius tripartito et in cupulam brevem depressam expanso (v Tab III, Fig 8), petalis anguste oblongis, non nervosis, apice acutis, deinde usque ad basin separatis; staminibus 6 paene separatis fertilibus, antheris mediatenus versatilibus, 2.5 mm longis (v Tab III, Fig 9), normaliter dehiscentibus polline bene formato (v Tab III, Fig 10) praeditis, filamentis atrocioratis mediae antherae adfixis, infra basin antherarum  $1\frac{1}{2}$  mm longis (Descriptio hucusque ex specimine "femineo" (meliuscule monoecio) typico *Rahmat 6172* incipit descriptio fructuum ex *Rahmat 7616* et inflorescentiae masculae ex specimine masculo typico *Rahmat 7340*) Fructus maturi vel paene maturi (v Tab III, Fig 12) 11-12 mm longi, 11-14 mm lati, stipite 2 mm. longo, mucrone 2 mm longo, lepidibus 12-seriatis, stramineis, margine cinnamomeis, longitudinaliter vix sulcatis; semine subgloboso, 10-13 mm diam, endocarpio crasso atrorubro, molli, in siccitate irregulariter foveolato, endospermio hemiocelluloso albo homogeneo late turbinato, latiore (8-9 mm) quam altiore (6-7 mm), ab intrusione endocarpi grosse foveolato (v Tab III, Figg. 13 a-c). Embryo et raphe exacte opposita, polaria (v Tab III, Fig 14). Spadix masculus longitudine varians usque ad 170 cm, in caudicula perbrevis sterili desinens (v Tab IV, Fig 16) ramos primarios, secundarios et tertiarios (i.e. spiculas) ferens, ramis secundarius ex oribus spatharum orientibus, longioribus eorum ca 15 cm longis, spiculas 8-15 laterales 2-8 cm. longas et spicam terminalem unicam quam lateralem propinquam duplo longiorem ferentibus. Spathae primariae ore longe obliquae, omnino inermes vel 1-2 spinis prope

insertionem praeditae, inter se amplectentes, infima ca 29 cm longa, semicylindrica, aliae sequentes omnes inermes (v Tab IV, Fig 16) subinfundibuliformes, intermediae ca 15 cm longae, superiores ca 4 cm. longae Spathae secundariae oribus magis patentes, nec sese attingentes, mediocres plerumque ca 4 cm longae, basi diam 3 mm, sursum expansae, apice obliquo 7-8 mm diam, papyraceae, sub lente venosae, tertiariae (spiculas subtendentes) similes sed parviores, saepe solum 6-7 mm longae, basi  $1\frac{1}{2}$ -2 mm latae, apice 3-4 mm, minores semicylindricae, infra ore obliquo applanatae, infra apicem rotundatae Spiculae in oribus obliquis spatharum orientes haud ex basi, non pedicellatae, usque ad basin floriferae, floribus distichis, plerumque 15-24 (v Tab IV, Fig 17) sed in spica terminali duplo pluribus quam in spicula laterali adjacenti, numero saepe 30 Spathellae rhachin amplectentes excentricae late naviculiformes valde venosae uno latere reflexae sed in apicem acutum inflexum productae Involucrum cupuliforme excentricum ad rhachin unilateraliter inter spathellas duas consequas adnatum (v Tab. IV, Fig 18) Flores masculi vix aperti ovoides 3 mm longi,  $2\frac{1}{2}$  mm crassi (v Tab IV, Figg 19-20) Calyx 18 mm altus solum tertia parte tripartitus, segmentis obtusis, crasse 9-11-venosis, sinibus latis rotundatis (v Tab IV, Fig 21) Corollae segmenta apice separata, acuta, deorsum connata, obscure ca 23-venulosa Stamina 2 mm longa, sagittata, filamentis crassis atrobrunneis basi inter se connatis cupulam carnosam formantibus, ad apicem versus angustatis; antheris ca 18 mm longis, albis, versatilibus, prope apicem affixis, deorsum bipartitis (v Tab IV, Fig 22) Pistillodium ex ovarii rudimento hyalino et 3 segmentis atrofuscis appressis subulatis constans (v Tab IV, Fig 23)

Of this interesting species excellent specimens are at hand from Asahan and Tapianoei, Sumatra, as follows

*Rahmat 6179* (type for monoecious or "female" plant, 16 sheets in Herb Mich); vernacular name *hotang saboet*, Tangga 2, District Pagar Batoe, Subdivision Habinsaran, Tapianoei Lowest spathe smooth

*Rahmat 7709*, also monoecious, vernacular name *hotang saboet*, vicinity of Loemban Ria, Asahan Lowest spathe smooth or sparsely spinulose.

*Rahmat 7816*; used for description of fruit; vernacular name *hotang*

*limoek*, vicinity of Loemban Ria, Asahan Agrees with the type in the lowest sheath being smooth, but has instead of a simple triangular second involucre (when this structure is not a complete annulus) one with two parallel linguiform appendages, which may fuse laterally Such a difference need hardly be considered of taxonomic value, since in the palms vestigial structures appear to be more variable than those which are functional They may even be present or not present in different parts of the same plant

*Rahmat 7340* (type for male plant, 17 sheets in Herb Mich ), vernacular name *hotang saboet*, vicinity of Hoeta Bagasan, Asahan Spathes all smooth

In the examination of the specimens here referred to *C leiospathus* no characteristic has come to light of greater interest than the dimorphism of the male flowers and the pollen The monoecious plant (corresponding to the functionally pistillate plant of most Calami) bears male flowers of narrowly cylindrical form with no pistillodium, with anthers attached near the apex, and with large pollen grains The purely staminate plant, on the contrary, has oval flowers with a three-parted pistillodium, anthers attached near the middle, and small pollen grains (Compare Pl III, Fig 10, and Pl IV, Fig 24 ) It appears likely that the unexpected differences between the sex forms have a genetic basis within the species, but to avoid confusion that might arise from possible mixture of material belonging to different species separate type specimens are indicated for the monoecious and the staminate plants Nomenclatorially, *C leiospathus* should be interpreted by the type specimen of the monoecious plant

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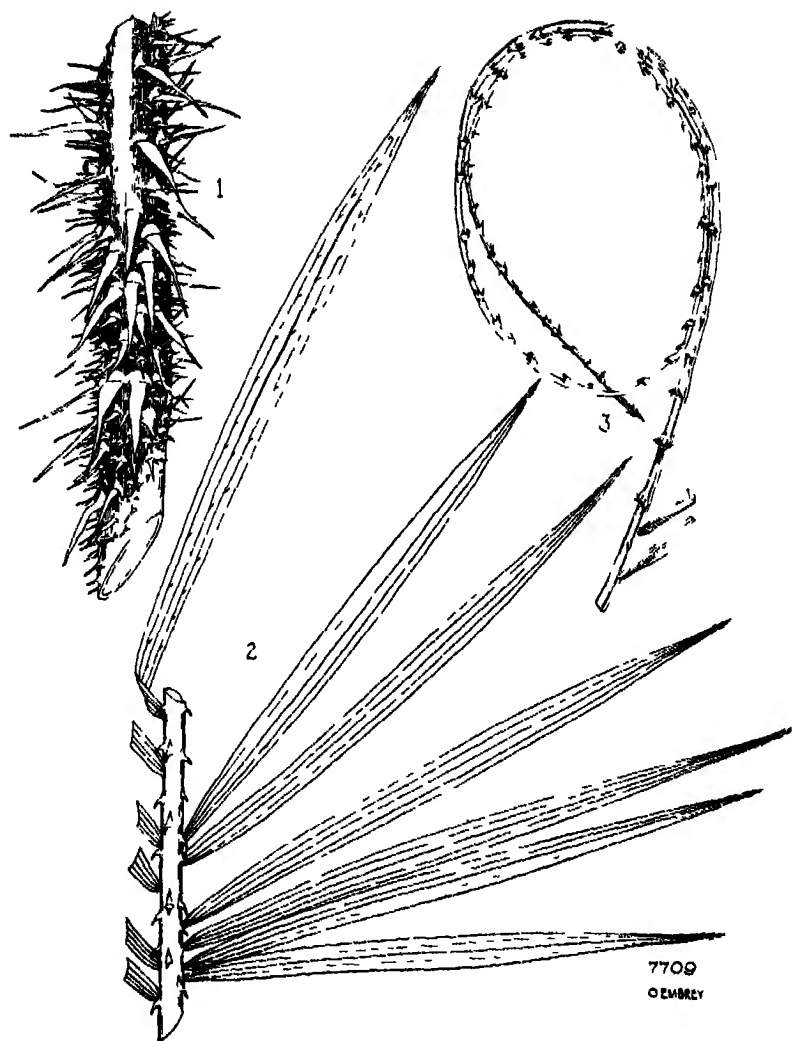
**PLATES I IV**

## EXPLANATION OF PLATE I

*Calamus lerospathus*, sp. nov.

All figures  $\times \frac{1}{2}$ , drawn from the type material of the so-called "pistillate"  
(actually monoecious) plant (*Rahmat 7709*)

- FIG 1 Sheath, showing at top nude area extending downward from the back of the petiole, and the lack of a conspicuous swelling at the base of the petiole
- FIG 2 Part of frond, showing irregularly aggregated leaflets and the bristles on three veins of the upper surface
- FIG 3 Apex of frond, showing strongly armed cirrus, a feature in which subgenus *Calamoxleya* resembles *Daemonorops*



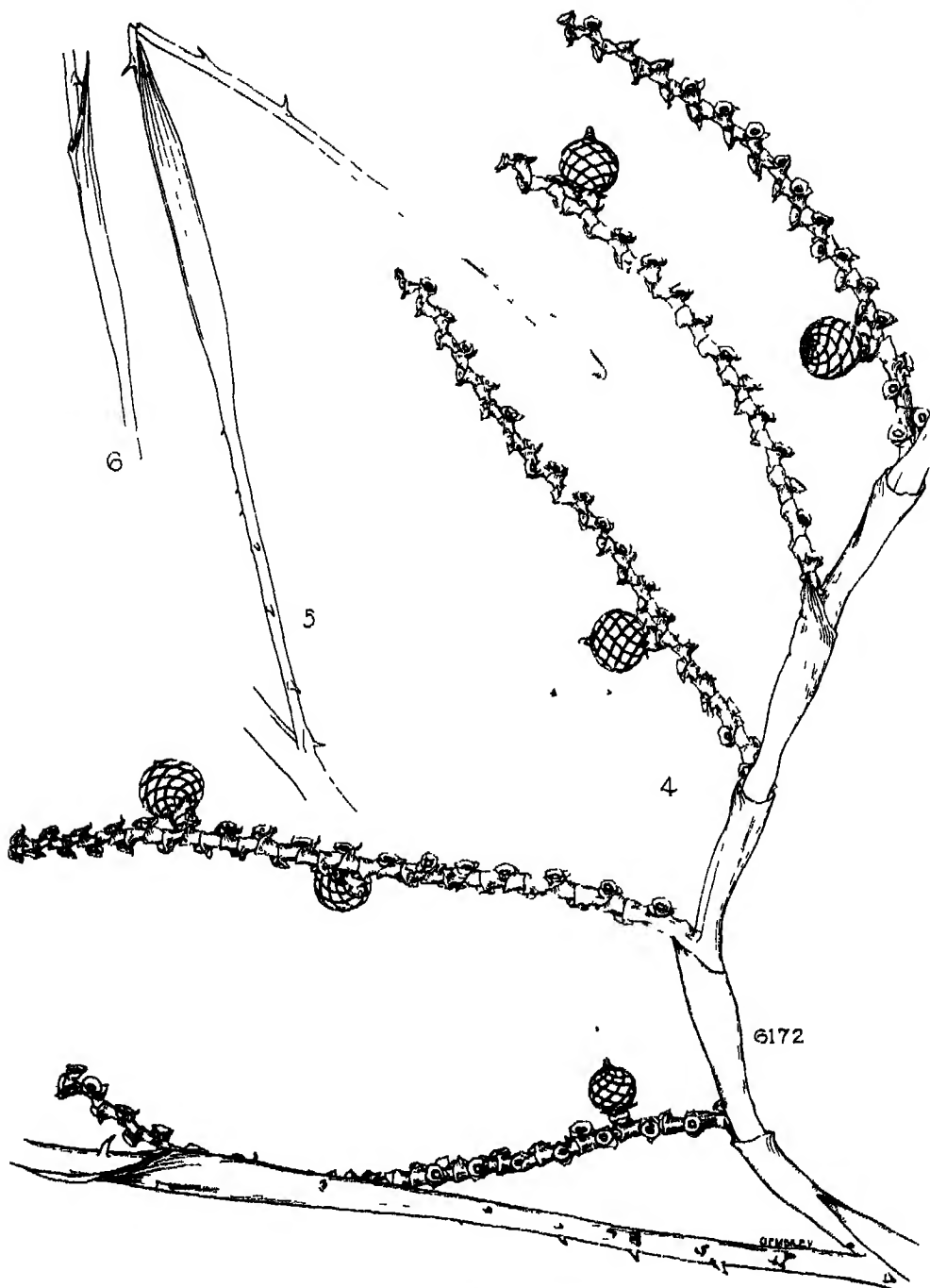
*Calamus (Calamoxleya) leiospathus*, sp. nov. Details of leaf

## EXPLANATION OF PLATE II

*Calamus leiospathus*, sp. nov.

All figures  $\times 1$ , drawn from a "pistillate" (i.e. presumably monoecious) plant (*Rahmat 6172*)

- FIG. 4 Part of spadix, showing the almost or entirely unarmed spathes and the spikelets from which most of the partly developed pistillate flowers have fallen. Note that many of the "involucres" (as, following Beccari, I have designated the structures bearing laterally the areole of the "sterile" flowers) contain a partly developed second involucre around the scar of the pistillate flower, it varies from a perfect annulus through a 3-, 2-, or 1-lobed structure to a mere vestige and is frequently completely absent.
- FIG. 5 The morphologically terminal portion (caudicula or rudimentary flagellum) of the spadix, weakly or hardly armed, with well-developed spathes.
- FIG. 6 Lower spathe of the vestigial flagellum, from side.



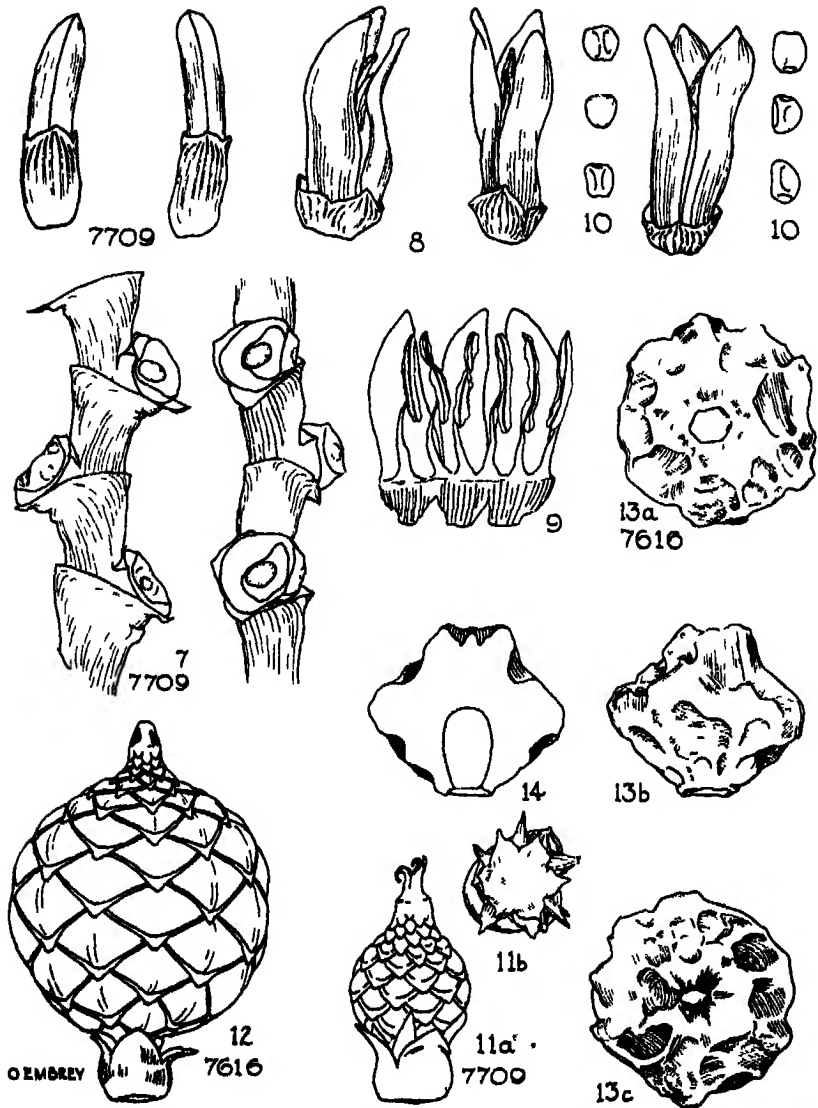
*Calamus (Calamozleya) leiopathus*, sp. nov. Details of ♀ inflorescence



## EXPLANATION OF PLATE III

### *Calamus leiospathus*, sp. nov.

- FIG 7 Parts ( $\times 3$ ) of spikelet of monoecious plant from which the flowers have fallen left, below, and right, middle, involucre from side, showing areole and scar of solitary male flower, left, middle, involucre from side, showing areole with scars of 3 male flowers, left, above, and right, above and below, view into the involucre, showing the irregularly annular (bilobed) second involucre (*Rahmat 7709*)
- FIG 8 Male flowers from monoecious (so-called "pistillate") plant ( $\times 6$ ) The two unopened buds (at left) with long narrow calyces may not inconceivably represent lateral flowers from areoles with three scars, such as that shown in the middle of Figure 7, left, but it is quite as likely that the calyx becomes spread out and depressed when the flowers open, as in the three more mature flowers shown at right The male flowers had all fallen from the scars and very few could be found (*Rahmat 7709*)
- FIG 9 Male flower laid open ( $\times 6$ ), showing the noncartilaginous filaments hardly if at all united at base, and the dehiscent anthers attached near or below the middle
- FIG 10 Apparently functional pollen grains ( $\times 150$ ) from the male flower shown in Figure 9 (*Rahmat 7709*)
- FIG 11a Developing pistillate flower with persistent perianth ( $\times 3$ )
- FIG 11b Vertical view of same with ovary removed to show firm 6-parted staminodial cup (*Rahmat 7709*)
- FIG 12 Mature fruit ( $\times 3$ ) from *Rahmat 7616*
- FIG 13 a, b, c Endosperm of same, in polar and lateral aspects
- FIG 14 Vertical section of endosperm ( $\times 3$ ), showing embryo (*Rahmat 7616*)



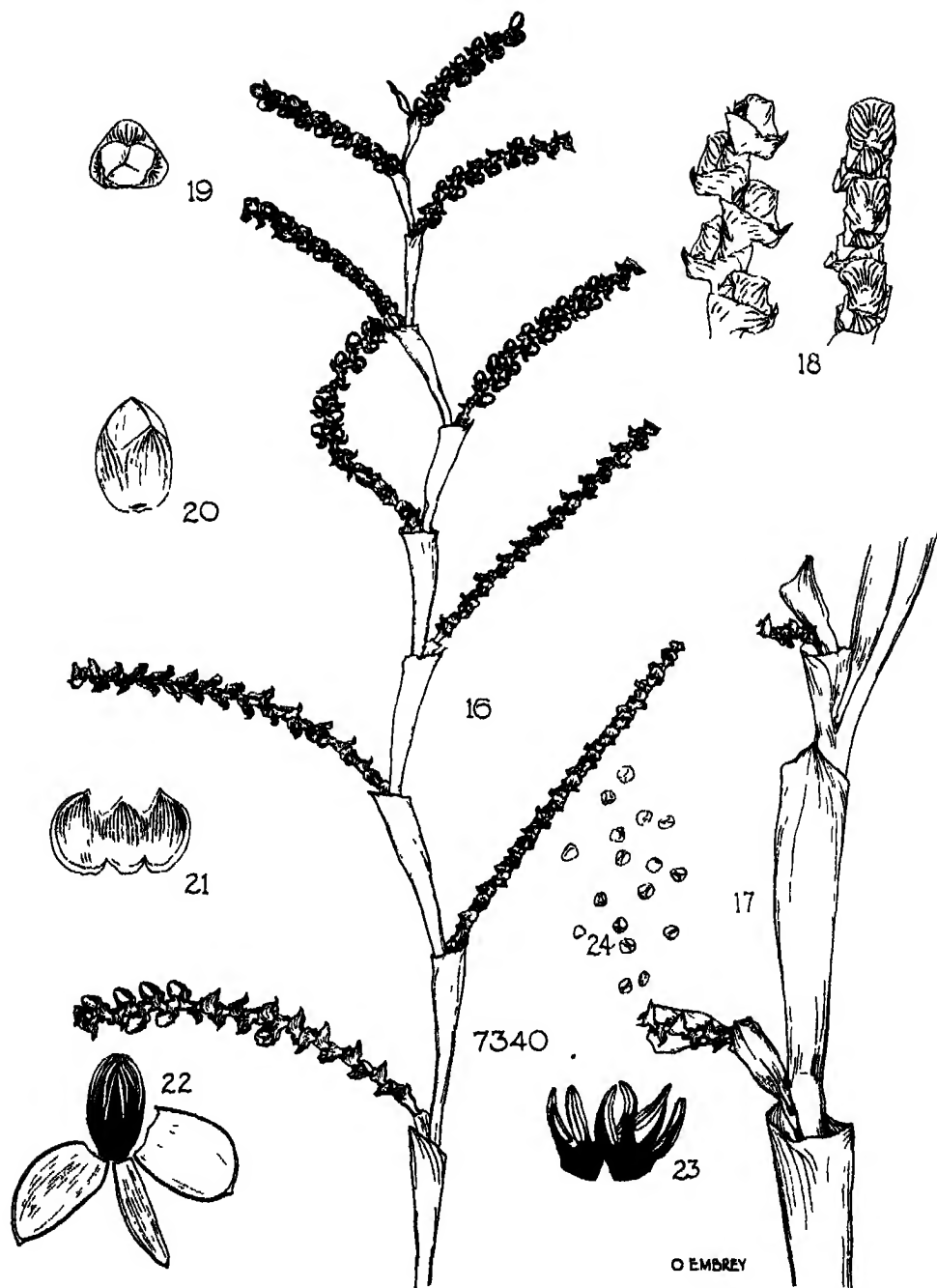
*Calamus (Calamoxleya) leospathus*, sp. nov. ♀ and associated ♂ flowers  
fruit and seed

## EXPLANATION OF PLATE IV

*Calamus leiospathus*, sp. nov.

All figures from *Rahmat* 7340

- FIG 16 Part of the unarmed staminate spadix ( $\times 1$ ), showing the entirely smooth spathe and the merely vestigial sterile terminal part
- FIG 17 Part of same ( $\times 3\frac{1}{2}$ ), showing origin of spikelets at about the level of the spathe orifice
- FIG 18 Fragments of spikelets ( $\times 4$ ), showing spatheae and involucres, and scars from which the staminate flowers have fallen
- FIGS 19-20 Apical and side views of unopened staminate flower ( $\times 4$ )
- FIG 21 Calyx of staminate flower laid open ( $\times 4$ )
- FIGS 22-23 Corolla of staminate flower removed, showing cartilaginous blackish staminal cup and versatile anthers attached far above middle ( $\times 4$ ) The pistilodum has a minute stipe and three separate, but appressed, vestigial carpels
- FIG 24 Pollen grains ( $\times 100$ ) Although the anthers from which the pollen was obtained had not yet dehiscent, the grains were probably nearly mature. Their size, which is much smaller than that of the grains from staminate flowers of the monoecious plant, is therefore very remarkable (cf Pl III, Fig 10, and Pl IV, Fig 24, allowing for different reduction). The grains in the latter are twice as long and several times as bulky as those in the former. So great a discrepancy in the pollen, and likewise the very different form and morphology of the male flowers borne by the two types of plant (i.e. monoecious and purely staminate), indicate some very remarkable genetical condition in the *Calami*, with respect to the inheritance of the sex forms, or else a failure to associate correctly the sex forms belonging to the same species.



*Calamus (Calamozleya) leiopathus*, sp. nov. Details of ♂ inflorescence and flowers



## VARICOSPORIUM ELODEAE KEGEL, AN UNCOMMON SOIL FUNGUS

ERNST A BESSEY

IN THE course of the summer foray of the Mycological Society of America, at and near Duchesnay, Quebec, in August, 1938, the writer collected several soil samples. One such sample from a good stand of *Abies balsamea* and *Betula papyrifera* near Lac St Joseph yielded several interesting fungi. A bit of the now dry soil was placed, on October 19, 1938, in a sterile Soyka dish partly filled with sterile distilled water, and two sterilized hemp seeds were added. Some weeks later a thin growth of hyphae occupied areas near the hemp seeds at or near the surface of the water and extending 4 to 6 mm. On this mycelium were borne the peculiar conidia of *Varicosporium Elodeae* Kegel, most of them submerged just beneath the surface of the water, but a few in the air, where they formed little tufts.

No sharp distinction between conidiophores and vegetative hyphae was possible in the material under observation. The terminal portions of main hyphae or of lateral horizontal or vertical branches become somewhat thickened, up to 3  $\mu$  in diameter, and remain straight or become somewhat curved. From these there arise branches at right angles or more acute angles, often on one side only, and these in turn bear similar branches. At the point of attachment they are rounded to a narrow, very short isthmus or they are completely sessile. The branching may become quite complicated and, in general, the branches lie nearly all in the same plane. The resulting structures frequently resemble Chinese printed characters, as is shown in Figures 1 and 2. The main axis and the branches of the first and succeeding rank are distantly septate at first, but the septations become more numerous as the spores become more mature (Fig. 1A, young spore; 1D, mature spore). The contents of the cells are very finely granular or even almost homogeneous in appearance, but there may be a few coarser granules also. With age

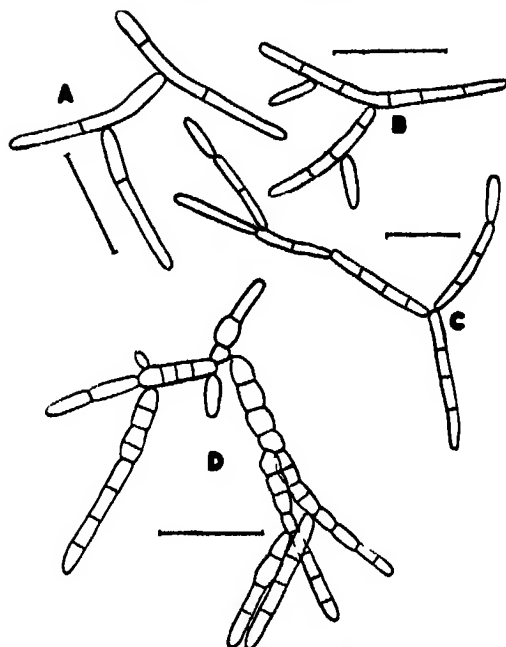


FIG 1 *Varicosporium Elodeae* Kegel, spores of various forms and ages. A and B, young spores, C, rather mature spore, D, mature spore. Each scale represents 25 microns

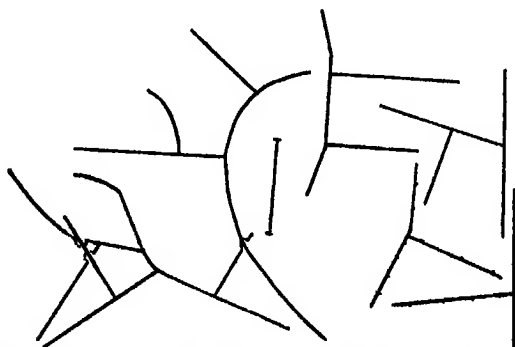


FIG 2 Diagrams showing spores of various sizes and modes of branching. The dots beside two of the figures indicate points of septation. The central scale represents 25 microns

the main axis and the longer branches become constricted into segments of 3 to 5 cells each, so that ultimately the system resembles a chain of several-celled spores with branches of the same nature. The length of the main axis ranges from about 40 to 100  $\mu$ , with a thickness of about 3  $\mu$ . The whole system is hyaline.

Kegel<sup>1</sup> described this fungus in 1906 as *Varicosporium Elodeae*, gen et sp nov. He found it growing saprophytically upon dead or dying shoots of *Elodea canadensis* used by him in physiological studies on that plant at Göttingen, Germany. His figures match in almost all particulars the spores found by the writer. Some of his spores were a little longer, and some attained a diameter of 4 or even 5  $\mu$ . He interpreted the main axes as conidiophores. He placed the organism in the Fungi Imperfecti, in the section Hyalophragmataceae of the Moniliales, in which section are found the genera *Ramularia* and *Septocylindrium*. *Varicosporium* has no close affinity with these genera, but since the families and tribes of the imperfect fungi are admittedly artificial "form" groups no criticism should be made of Kegel's disposition of his new genus.

Apparently the fungus is rare or has not been recognized, for the available mycological literature and abstract journals have no reference to it aside from Kegel's original paper.

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<sup>1</sup> Kegel, Werner, "Varicosporium Elodeae, ein Wasserpilz mit auffallender Konidienbildung," *Ber deutsch bot Gesellsch*, 24: 213-216, 3 figs. 1906.





# ANATOMY OF *URGINEA MARITIMA* (L.) BAKER

DOROTHY CHAPMAN CARPENTER

**U**RGINEA is distinguished from *Scilla* in Engler and Prantl (10) by its compressed angular seeds and deciduous perianth segments; in *Scilla* the seeds are conical or obovate and the perianth is persistent. *U. maritima* (L.) Baker (*S. maritima* L., *U. Scilla* Steinh.) is found in the Canaries and along the shores of the Mediterranean Sea from Spain to Syria.

From the anatomist's standpoint three features of this plant are of particular interest. One is the presence of a cambium, which extends as a ring in the cortex of the stem plate and produces on the inner side amphivasal bundles which are scattered in parenchymatous ground tissue. Scanty parenchyma is formed on the outside. The second is the group of bulbils on the outer surface of each bulb scale by which vegetative reproduction takes place. They arise from the intercalary meristem of the scale base, where they remain connected with it as the scale grows by promeristematic strands, which later become vascular. Each bulbil has a meristem which cuts off small scales as the bulbil develops. The third feature is the method of splitting of the terete leaves by which they give rise to the flat basal part of the leaf. For varying lengths at the tip they are round and solid. Then, as they grow basally from the meristem of the stem plate, the meristem changes from round to the strap-shaped intercalary meristem of the leaf base. As a result the leaf tip splits, and in all future growth the leaf is flat and ribbon-like (3).

The material of *U. maritima* used in this study was originally introduced in 1910 from the Reale Giardino Botanico in Palermo, Sicily, by the Botanical Gardens of the University of Michigan, where the species has been grown since that time.

## GENERAL CONSIDERATIONS

The bulb of *U. maritima* may reach a diameter of one decimeter and weigh as much as two kilograms. At its base there is a stem

plate, in part meristematic, which gives rise to leaves and flower stalk and to a fibrous root system. The checked parts in Figure 1 (Pl I) are meristematic, the solid black region is the cambium. The fleshy bases of from ten to twenty two-ranked lanceolate gray-green leaves compose the greater part of the bulb. The leaves turn brown at the tip and die back slowly as they grow older, and the next younger scales successively become the outermost. As a scale dies and peels off, its own bulbils fall to the ground and root. The bulbils of the next scale are then uncovered, for their outstanding morphological peculiarity is that they are borne not in an axillary position, but on the outside of the scale.

Each year the stem plate produces one flower stalk, which bears a terminal raceme of numerous small green-striped white flowers (4). The angular black seeds germinate readily in the soil, very much as do those of *Allium* (12), and the seedlings yield bulblets similar in appearance to the asexually produced bulbils which have dropped to the ground and formed roots and leaves.

#### THE BULBIL

In each scale the bulbils vary in arrangement, but often have the aspect of one at the apex of the group and the rest in two irregular rows. A vascular strand connects each one directly with the stem plate or indirectly by fusion with the strands of subsequently formed lower bulbils. There is no uniformity in the vascular supply of the bulbils, each scale shows marked variations.

As the scale develops basally from the meristem the meristematic strand from the oldest, uppermost, bulbil persists with or without branching or giving rise to younger, newer, bulbils and eventually is differentiated from above downward as a vascular strand. The varying course of the strands and arrangement of the bulbils on different scales are shown in Figures 2-14. A bulbil is roughly triangular (Figs 3-4), and a hollow is formed in the scale beneath it by the pressure of its growth (Fig 5).

The bulb of a typical plant which was completely dissected is shown in Figure 2. One group of immature bulbils is present on the outermost scale, the largest at the top. On the first inner scale is a group of five bulbils smaller than those on the outside (Fig 6); the second scale from the outside also has five (Fig 7); the third has eight (Fig 8); the fourth has three (Fig 9); the fifth has but

one bulbil at this stage (Fig 10), and the sixth scale has, near the base, but one barely perceptible swelling, which is the beginning of a bulbil (Fig 11) This sixth scale continues, as the youngest leaf, to extend above the top of the bulb Scale seven has no visible bulbils and is almost paper-thin at the base, the split in the eighth scale (Fig 12) continues almost to the stem plate, with the flattened leaf rolled tightly around itself Scale nine is similar, except that the split in it extends down to the stem plate, scale ten (Fig 13) is represented by a solid round tip, except at the base, where a split is just beginning to appear The innermost structure of the bulb (Fig 14) is four millimeters long and is the solid tip of the youngest leaf

Long before a bulbil is in any way apparent on the surface of the scale divisions occur in certain scale cells as they are being formed from the meristematic region of the stem plate These divisions continue in a very small area, and as a result form a bulbil instead of ordinary scale tissue (Fig 15) During the early differentiation of bulbils, which are then so young as to be barely visible to the naked eye, they are connected by procambial tissue continuously with the promeristem of the stem plate As the scales become older there is progressive differentiation of the strands into xylem and phloem from above downward But so long as the basal growth of the scale continues, the base of the strand remains procambial

Serial cross sections were made through the youngest bulbil visible to the naked eye, which appeared as a slight swelling on the surface of the scale with no differentiation of parts A section directly through its center shows the meristematic region which has appeared in the scale (Fig 16) A somewhat older bulbil, which had differentiated enough for its tip to be entirely unattached to the bulb scale, was also studied in detail The extreme tip is of undifferentiated parenchyma At a lower level the meristematic region which cuts off the young scales is apparent, three meristematic strands go from the bulb scale through the bulbil base up to the meristematic region (Fig. 17)

A longitudinal section through the center of a bulbil old enough to have a stalk attaching it to the scale, but not yet mature, shows that xylem and phloem are being differentiated. Promeristematic strands continue up to the central meristematic region, which is deep within the bulbil, beneath the four scales which have already

been formed (Fig 18) A transverse section through a mature bulbil stalk attachment shows the stalk to be of smaller parenchyma cells than those of the scale

A large number of mature bulbils dissected just after being shed proved to have the same general anatomy A median longitudinal section shows that the four outer scales do not have solid tips They extend to the top of the bulbil, each younger one being slightly longer than the last. Their epidermal surfaces are of similar rectangular cells, and there are no stomata The fifth scale inward has a solid tip which reaches somewhat beyond the top, having mechanically, through continued growth, forced its way through the outer scales which originally extended over it Within it, and at about half its length, is the sixth leaf, of which only a part of the solid tip has been formed Each scale rises at the base from the stem plate, which is a well-differentiated region (Fig 19)

During the last ten years considerable study has been made of reproduction in many bulbous monocotyledonous forms by means of small vegetatively produced bulbils Chouard (6-7) mentions several of the various types found in the Scilleae Some, such as *Muscari racemosum* Mill and *Ornithogalum nutans* L produce bulbils around all of the outer base of the bulb; these bulbils later become detached and develop independently More frequently, however, bulbils are produced singly on the inside at the base of an outermost scale, i e in a demonstrably axillary position Here they remain until freed by the decomposition of the outer scale or form leaves and roots and develop *in situ*. This type is found in *Scilla verna* Huds, *S. peruviana* L, and other species Neither of these manners of bulbil formation — and they are not necessarily fundamentally different — is similar to the mode of production in *Urginea*, however, for in the two former types the bulbils arise from stem tissue, whereas in *Urginea* they arise from cells on the outer surface of the bulb scales, far above the level of the stem plate.

In *Erythronium* (15) and *Tulipa* (2) a small bulblet is carried downward into the earth on the end of a "dropper," which is a modified continuation of the base of the foliage leaf. In some species this bulblet produces a single foliage leaf the next year, and it is in turn prolonged at the base into a dropper, which carries the terminal bud downward into the soil This may be repeated for several years, as in *Tulipa sylvestris* L and *T. saxatilis* Sieber. In

other kinds the bulblet elongates each year and produces a flower scape. In such a plant the dropper for the next year's growth is formed from a lateral bud and penetrates but a short distance beneath the soil surface (Tulipa, garden variety)

L. Daniel (8) found that, when *Allium Porrum* L is grown in light of low intensity, it flowers late and there are fasciations and proliferated flowers in the inflorescences. In some of the proliferated flowers bulbils occur at the base of the proliferations, and in others, as is a common occurrence in *Cyperus dentatus* Torr and *Juncus pelocarpus* Mey, they may replace the spikes of flowers.

The bulbils in *U. maritima* seem different from any of those mentioned by other investigators. Their occurrence is in a single vertically arranged group on the outer surface of every scale. They are not connected with the inflorescence in any way, nor are they formed from the stem plate. Both an annual stalk and the bulbil group on each scale appeared on all the mature plants available for study.

#### TRANSITION FROM ROOT TO STEM OF PLANT FORMED FROM A BULBIL

A four-month-old plant grown from a bulbil was sectioned to show the root-stem transition; it had four roots and one leaf, which was five centimeters long. The two outermost scales were dry and brownish and had partly died back toward the base, and so were removed. The young solid round leaf has four collateral vascular bundles, with the endarch xylem innermost. The general tissue is parenchymatous, with a thin-walled epidermis and scattered stomata. At the level of the top of the bulb the solid terete leaf has six promeristematic strands arranged in a circle, and the scale around it has six promeristematic strands alternating with six vascular bundles. A short distance below this the tip of a still younger leaf appears in the bulb center, it contains one promeristematic strand, and its general tissue is parenchymatous. There are three scales around it, the innermost of which has one bundle and four promeristematic strands. The next outermost has seven bundles and seven alternating promeristematic strands, the outermost scale, eleven bundles (Fig. 20).

The tip of the stem plate is entirely meristematic; the bundles in the scales around it remain the same. At a slightly lower level

the central bulb area contains four promeristematic strands and one bundle, which are arranged in a ring around the large central meristematic area. Numerous starch grains are stored in the outer scale. Some are very large, and their lobed, forked, round or angular hila may be easily seen. The vascular system undergoes change just below this level. In the bulb center two promeristematic strands on each side unite with each other, and the promeristematic area, which was in the center at a higher level, curves out as a strand to make a fourth in the ring. A small amount of xylem is differentiated in one of the pairs of united meristematic strands. The bundles in the scales turn in toward the bulb center, and as the level of the union of scale bases with stem plate is reached no splits between the scales are visible.

The cells of a large part of the outer region contain masses of small round bodies, which take a deep pink stain with safranin. These masses are soluble starch, as they gradually accumulate in a cell the large starch grains which formerly filled it are correspondingly fewer. In the normal state the starch grains do not gelatinize because of a cellulose protective coating which prevents water from reaching the starch substance (13). It is possible that at the basal meristematic region of the stem plate there is given off an enzyme which makes soluble the outer coating of the starch grains stored in the scales. This soluble starch probably provides the energy for the cell formation and growth which occur in the stem plate.

At lower levels of the bulb the three central areas of xylem, phloem, and undifferentiated parenchyma each divide in an inverted V, and several of these subdivide, forming ten small bundles with xylem and five promeristematic strands. Just below this a cambium forms an interrupted ring around the central part of the bulb. In the very center are the regular primary tissues, and outside them, reaching the cambium, are the secondary tissues.

In a plant but four months old the amount of secondary tissue is small; it consists of a few amphivasal and collateral bundles and several still promeristematic bundles scattered in parenchyma tissue. The cambium extends downward in the bulb for a short distance. Below it a number of thick vascular strands of primary origin descend from the central region. The exterior of the bulb is uneven in outline and rough where portions of it have sloughed off because of contact with the soil. The vascular strands gather into three definite

groups, and from them arises the vascular tissue which supplies the adventitious roots (Fig 21) The region of gelatinized starch grains, which is smaller, finally disappears as lower levels are reached The roots grow down through the bulb stem-plate base and out into the soil

There are two types of vascular systems in the roots One has five or six protoxylem "rays" coming off from three or four large metaxylem vessels in the center of the root, with patches of phloem in between the rays The other type, which was found in only one of several dozen roots that were examined and which is polyarch, has nine small groups of protoxylem, each consisting of from one to three tracheids arranged in a circle, alternating with nine phloem groups An endodermis differentiates a few cells at a time in the cortex of each root

In a mature plant several years of age in which the bulb is five to eight centimeters in diameter the proportion of tissues of the stem plate is different from that in the young plant just developing from a bulbil The greater part is secondary in origin, there is a small amount of primary tissue in the center, with several wide vascular strands arising from it (Fig 22, Pl II) The cambial cells are vertically elongated In cross section the radial dimension is far less than the tangential, and the cells are much smaller than adjoining parenchyma cells They do not have tapering ends The cambium extends in a circle within the cortex, and the divisions within it are chiefly tangential Most of the tissue formed by it is toward the center of the stem, with but a scanty amount of parenchyma on the outside

The older secondary bundles, which have well-differentiated xylem and phloem, are toward the stem center (Fig 23) Nearer the cambium the younger bundles have little or no xylem or phloem yet visible For a distance inside the cambium the interfascicular parenchyma shows its radial arrangement The vascular bundles arise at intervals by the divisions, first in the radial and then in all planes, of mother cells which are formed by the cambium (Fig 24) Eventually phloem and xylem are differentiated, and a mature functional amphivasal bundle exists This type of secondary growth in Monocotyledones is very slow and may continue almost indefinitely.



## THE CAMBIUM OF THE MONOCOTYLEDONES

Whereas the Monocotyledones as a class do not have extensive secondary growth as a result of interfascicular cambial activity, intrafascicular cambium does occur in many monocotyledonous plants. The first observation appears to be that of Russow (14) concerning cambium in the vascular bundles of *Hemerocallis fulva* L. Subsequently, according to Arber (1) in her series of articles on the cambium in Monocotyledones, one or more instances of intrafascicular cambium have been recorded in the following families: Typhaceae, Potamogetonaceae, Scheuchzeriaceae, Gramineae, Cyperaceae, Palmae, Araceae, Commelinaceae, Liliaceae, Dioscoreaceae, Iridaceae, Musaceae, and Zingiberaceae. This leaves but three of the cohorts into which Bentham and Hooker divide the Monocotyledones, the Triuridales, the Synanthae, and the Microspermae, in which such a cambium has not as yet been reported.

In addition to an intrafascicular cambium a special type of secondary thickening occurs in a few monocotyledonous forms in which a cambial layer is formed from the meristematic parenchyma of the pericycle or innermost cortical cells, which produces on its inner side whole amphivasal or collateral bundles embedded in ground parenchyma, and on the outer side small amounts of parenchyma. Reports have been made of such cambium in *Dracaena*, *Aloe*, *Yucca*, *Agave*, *Cordylus*, *Dasylium*, *Testudinaria*, *Dioscorea*, *Aristea*, and related genera. A similar cambium was found in the stem plate of *U. maritima*, the first to my knowledge to be reported in a liliaceous plant which retains a nonwoody succulent bulb its entire life.<sup>1</sup>

## SEED GERMINATION AND SEEDLING PLANT

The fruit of *U. maritima* is a capsule, and there are about four black sharply angled seeds in each of the three locules (4). They germinate readily by either of two methods. In the majority growth occurs first at the lower and middle regions of the cotyledon, forcing the root and cotyledon through the seed coat. When the cotyledon is from four to six millimeters long it begins to turn downward, with the bending occurring in the elongating region just above the stem.

<sup>1</sup> After the writer's work on *Urginea* had been completed *Veratrum viride* Ait. was reported by Cheadle (5) as having such a cambium.

plate (Figs. 25-27) In a short time the root, which has root hairs over a large area, points downward Equal growth then takes place in two regions, one a short distance above the stem plate and the other just below the seed The result is that the bent cotyledonary portion is pushed up above the surface of the soil while the remainder of the seedling is still beneath

Ten days after planting the first seedlings appear above the ground The bent cotyledon slowly straightens, and the seedling becomes upright (Figs 28-32) The second type of germination begins in the same manner as the first, and is the same up to a length of four to six millimeters, when the basal portion of the plant begins to turn downward Whereas in the first type the bending occurs in the elongating region just above the stem plate and growth afterward takes place there and below the seed, in the second type the bending downward occurs only in the region below the seed But no elongation takes place at any time afterward in the region directly below the seed, all of it being above the stem plate Therefore no loop is formed, instead the cotyledon and seed are forced straight upward through the soil (Figs 34-42)

There is great variation in the time lapse before other roots appear on a seedling, but usually a second one is formed three or four weeks after germination It arises from the stem plate beside the radicle, which after a short time usually shrivels and dies, and is similar to it in shape and structure (Fig 33) Other roots appear at short intervals, six being found on one plant three months old At any time after three weeks a small slit appears in the cotyledon above the stem plate, and through it protrudes the solid round tip of the first leaf. Growth of the cotyledon ceases, and the new leaf grows rapidly from the base

Serial cross sections were made of several seedlings six months old In general structure they are similar to young plants formed from bulbils. There are minor differences of bundle number in the young solid leaf tips, and either three, four, or five protoxylem rays come off from the three or four metaxylem vessels in the roots Both plants grow similarly from a basal meristematic region in the stem plate, form a cambium, have leaves with solid tips and flat basal regions, and are otherwise alike

## EVOLUTION OF THE MONOCOTYLEDONES

In general, it seems to be agreed that the Monocotyledones have evolved from a dicotyledonous ancestry, probably from types close to the Ranalian level. Beyond that opinions differ greatly. It seems probable (9, 11) that true woodiness in Dicotyledones is primitive, and herbaceousness an advanced condition which has arisen independently in various groups, whole segments of the central cylinder having become transformed entirely into parenchyma in connection with the departure of leaf traces. When a cylinder is split up the cambium continues as an unbroken ring for a time, with the interfascicular portions forming parenchyma. Then as the plant becomes still more herbaceous the interfascicular cambium becomes less active and eventually disappears. Later the fascicular cambium also ceases to function, and the highest type of dicotyledonous bundle is found.

Loss of the cambium as an entire ring had probably already taken place in the herbaceous Dicotyledones before the Monocotyledones evolved. An intrafascicular cambium, however, remained in the ancestral Dicotyledones and would therefore be expected to occur in the Monocotyledones derived from them, as it actually does. The type of cambium found in a ring in such Monocotyledones as *Dracaena*, *Aloe*, and *Urginea*, is obviously different from that found in the Dicotyledones. Some investigators consider it an early development in the history of the Monocotyledones, which so successful a woody group as the *Palmales* reached long ago. Others regard it as comparatively recent.

Such plants as *Veratrum* and *Urginea*, which possess an active cambium but which remain herbaceous and succulent their entire lives, may also be viewed in two ways. They may possibly represent lines of evolution in which the cambium is just beginning to appear and in which it has not as yet reached its complete development, or, on the contrary, they may be plants which had woody monocotyledonous ancestry from which herbaceous types have again evolved, with the cambium still active but rudimentary in comparison with its former state.

Probably future investigations will disclose other Monocotyledones below the woody condition, with cambium in various stages of development. A study of such closely related genera as the woody

Agave and the herbaceous *Manfreda* might reveal many interesting facts. It is hardly possible that during the long-persisting rosette condition in the gigantic species of Agave there is nothing comparable to the cambium of *Urginea*. If it is present in true Agave (of the maguey type) and also in the herbaceous *Manfreda*, we would be presented with an interesting pair of undoubtedly allied plant types in which to trace persistence of cambium during retrogressive evolution or, conversely, its appearance *ab initio* in progressive evolution from the small herbaceous to the large woody type. *Urginea*, unfortunately, cannot clearly and certainly be associated with any woody type.

#### SUMMARY

1 *Urginea maritima* is a liaceous plant of very unusual vegetative morphology, as is indicated by the two remarkable features that have been described involving the distribution of meristematic tissue. In view of the fact that the bulbil formation is equally remarkable, yet of a type that is not known to occur in any other plant and certainly cannot, therefore, be looked upon as a feature of phylogenetic importance, one should be cautious about too far-reaching an application in a phylogenetic argument of the findings with regard to the cambium.

2 Each scale bears on its outer surface a group of small bulbils which arise from the intercalary meristem of the scale base. As the scale grows they remain connected with the intercalary meristem by promeristematic strands which later become vascular. Each bulbil has an apical meristem which cuts off the small scales as the bulbil develops. Upon contact with the soil when mature each bulbil can produce another plant, vegetatively. This type of bulbil and its position are unique; bulbils are usually at the bulb base between scales, in an axillary position in the inflorescence or at the end of vegetative droppers. Plants formed by the growth of bulbils are very similar, anatomically, to seedlings of comparable size.

3 The stem plate of *Urginea* contains a cambium which forms secondary amphivasal and collateral bundles scattered in parenchymatous ground tissue. Scanty parenchyma is formed outside the cambium. The plant, however, remains fleshy and nonwoody its entire life. The greater part of the plant tissue is parenchymatous, no sclerenchyma was found in any region. All bundles of the leaf,

flower parts, and peduncle, and primary tissues of the stem are collateral, with the endarch xylem innermost

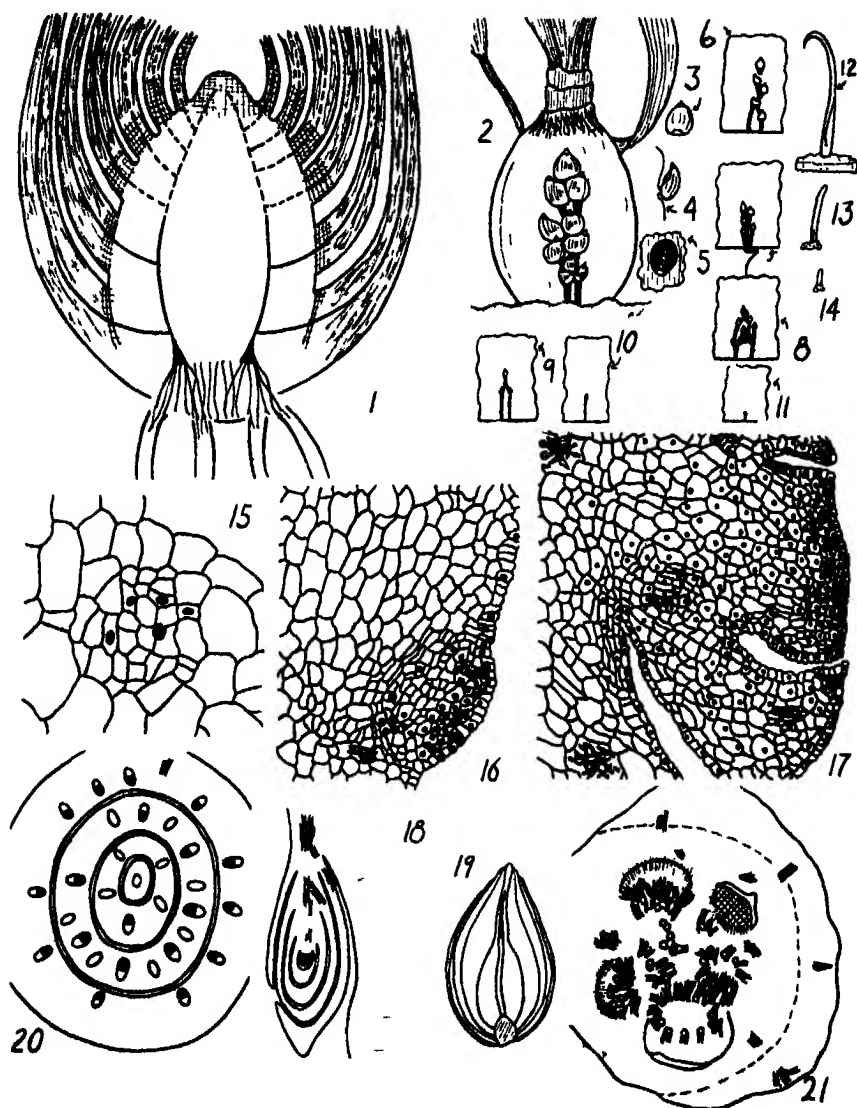
4 The adventitious roots in cross section usually have five or six protoxylem rays coming off from three or four large metaxylem vessels in the root center, with phloem between the rays

I wish to express appreciation to Dr Carl D La Rue, of the Botany Department of the University of Michigan, for suggesting the problem, and to Professor H H Bartlett, head of the Department, for inestimable aid

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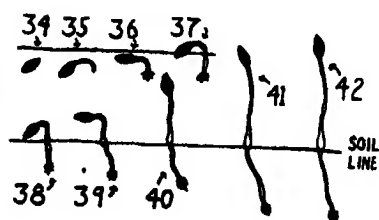
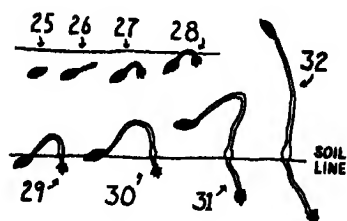
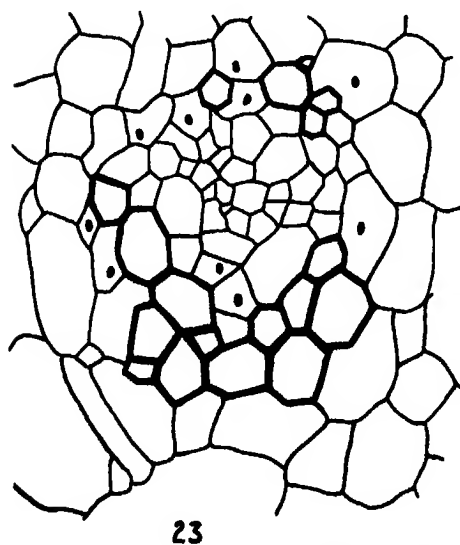
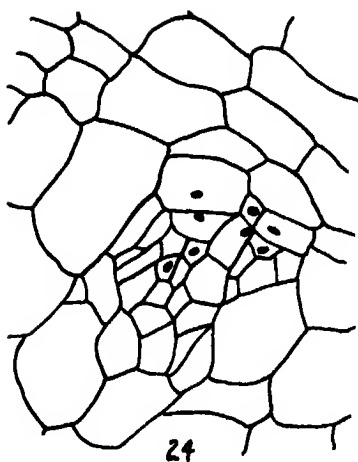
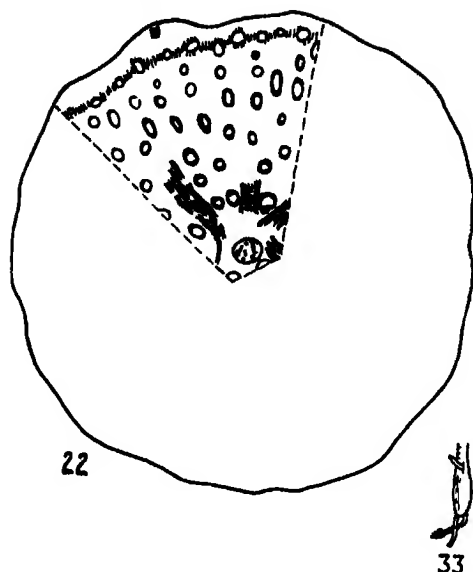


*Urginea maritima* (L.) Baker

FIGS 1-19 Habit sketches and sections of bulb and bulbil formation

FIGS 20-21 Transverse sections of root-stem transition of plant formed from a bulbil  
Figure 20 is through tip of youngest leaf, Figure 21 shows vascular supply of adventitious roots





*Urginea maritima* (L.) Baker

FIGS 22-24 Secondary bundles formed by cambial activity in the bulb stem plate  
 FIGS 25-42 Two methods of germination of seed and seedling growth





## SOME VEGETATIONAL ASPECTS OF BEAVER ISLAND, LAKE MICHIGAN

HENRY TOWNSEND DARLINGTON

**B**EAVER ISLAND (sometimes called Big Beaver) is the largest of a group of islands of the same name in Lake Michigan. The mean latitude for the center of the group is  $45^{\circ} 43' N$  and the mean longitude  $85^{\circ} 32' W$  (see Fig 1). The islands vary greatly in size. The largest one is Beaver, with an area of over fifty square miles, the smallest ones, some of which are apparently unnamed, consist of little more than shoals. The nine largest, arranged in the order of decreasing size, are as follows: Beaver, Garden, High, Hog, Gull, Whiskey, Trout, Squaw, and Hat. Beaver Island is approximately nineteen miles west of the nearest shore line in Emmet County, Michigan. The smaller islands lie within a radius of twelve miles of Beaver Island, the nearest being Garden Island, less than one and one-half miles north and slightly east, and the farthest, Gull Island, which is due west.

In early September, 1922, the writer spent nearly a week on Beaver Island and, in addition, one-half day on Garden Island studying and listing the distribution of the higher plants and ferns. This work was done in connection with the Land Economic Survey, in charge of L. R. A. Schoenmann, with headquarters on Fox Lake (Pl I, Fig 1), near the center of Beaver Island.

Beaver Island is approximately thirteen miles long, with its greatest width slightly over six. The northern part is underlain by limestone formations which outcrop at points. Much of the interior is gently rolling, corresponding with the original glacial drift. The surface ranges from forty to eighty feet above Lake Michigan. Around the border are glacial sand and shingle beaches, on some of which the wave-cut terraces of glacial Lake Nipissing may be traced. Back of the shore line there is in places a zone of dunes, which reaches its highest development on the west side of the island (Pl II). The highest point of this dune complex is known as Mount Pisgah. This

dune, which is west of Faunt Lake in the northern part of the island, is said to be two hundred feet high. Its topmost portion is believed to have been circled by the waters of glacial Lake Algonquin.

Beaver Harbor, in the northern part of the island (Pl. III, Fig. 1), is a landlocked bay opening like a horseshoe toward the east and possessing several natural advantages. On the west shore of the bay the rambling fishing village of St. James was established at an early date. Here climatic records were kept for a period of twenty-three years, from 1905 to 1927, after which they were apparently discontinued. As might be expected, the island has a more or less equable or maritime type of climate. This is indicated by certain aspects of the vegetation. The writer was surprised by the size and the vigor of beech (*Fagus grandifolia*). The average yearly temperature for the period recorded was 42.8° F., the mean maximum, 50.8° F., and the mean minimum, 35°. The greatest recorded extremes were 97° F. (in May!) and -28° F. (in December). The mean date of the last killing frost was May 14, and of the first killing frost, October 13, which gives a growing season of 152 days. This is 14 per cent longer than the growing season in Emmet County, at approximately the same latitude. The average annual rainfall recorded was 24.66 inches, with the maximum in October and the minimum in March.<sup>1</sup>

Apparently settlement of Big Beaver has been more meager than was originally anticipated. The earliest highway constructed was that south of St. James (Pl. III, Fig. 2). This part of Big Beaver is rather level and sandy, a condition which necessarily forms a background (from a phytogeographic point of view) for the type of vegetation found there. Some of the less desirable land in the southern part is not readily accessible. The better areas of virgin timber were undoubtedly cut long ago, since settlements on the island by French Canadians began at a very early date, even preceding the settlement of the Pilgrims at Plymouth Rock.<sup>2</sup> The settlement of St. James, on the north end, was the original county seat of Emmet County. It became the center of extensive lumbering and fishing interests, and also headquarters of the Mormons<sup>3</sup> in this region, under the notorious

<sup>1</sup> For the climatic records given above the writer is indebted to Mr. H. M. Wills, of the United States Weather Bureau at East Lansing, Michigan.

<sup>2</sup> "A Short History of the Beaver Islands," *Michigan Pioneer and Historical Collections*, 32 (1902), 176-179, 1903.

<sup>3</sup> Swift, Ivan, "The Vanished Kingdom," *Michigan History Magazine*, 12, 443-449, 1928.





"King Strang" There are considerable stands of second growth, especially in the north-central and eastern parts of the island. Extensive tracts in the southeastern part have been cut over and burned. This area is being invaded by second growth, including willow and aspen, with white cedar and spruce in the wetter grounds. West of Lake Genesareth are considerable stands of swamp timber. The best farming and improved land lies in the northern half.

Throughout the island are stretches of swampy land, small areas of improved land or pasture, and several lakes. The two most important lakes are Faunt Lake, already mentioned, and Lake Genesareth (originally called Lake Galilee), near the south end. The latter has an area of about a thousand acres. Smaller lakes are Fox Lake, Egg Lake, Round Lake, Barney Lake, and Greene Lake (see Fig 1). Of these, Fox Lake (Pl I, Fig 1) may be taken as typifying the general character of the vegetation and shore line around the smaller lakes.

The flora of the island is related closely to that of Emmet and Charlevoix counties along the Michigan shore line. Botanical interest naturally centers around the native flora. However, about seventy-five foreign species were noted by the writer, the majority in and near the small settlement of St James. A few were found on Garden Island also, which for many years has had small lumbering interests. The distribution of the native vegetation is to be accounted for by the diversity of physiographic features, comprising upland forested areas (Pl I, Fig 2), open sandy stretches, dunes, cedar swamps, lake borders, marshes, and a more or less irregular shore line.

North and west of St James there is a zone of sand averaging approximately one-half mile wide. This is covered by an open type of forest in which white pine, red pine, and red oak are dominant, these occur also along the low-lying shore of Beaver Harbor (Pl III, Fig 1). Scattered representatives of other tree species are found with those mentioned, the most noticeable of which are *Abies balsamea*, *Picea glauca*, *Betula papyrifera*, *Populus tremuloides*, *Populus grandidentata*, and *Ostrya virginiana*. Where the forest borders directly on the shore, common species are *Tsuga canadensis* and *Thuja occidentalis*. The low juniper, *Juniperus communis* var. *depressa*, is common on these sandy areas. Sometimes it grows in large circular patches, which are very attractive. In similar situations, but less

frequent, is the creeping juniper (*Juniperus horizontalis*), which often forms dense mats containing several square yards

The dune topography varies from gently rolling ground to areas in which the dune complex becomes quite rough. An illustration of the latter type of topography occurs west of Faunt Lake and includes Mount Pisgah. On the top of this dune, vegetation is very sparse, but one of the surprises was the occurrence there of beach grass (*Ammophila breviligulata*), though it was not seen along the immediate shore line, where it might be expected.

At present, stands of virgin timber form a comparatively small proportion of the total area of Beaver Island. Where typical mesophytic woods occur the two most valuable tree species are *Fagus grandifolia* and *Acer saccharum*. Associated with these are *Tilia americana*, *Prunus serotina*, *Quercus borealis* var. *maxima*, and several woody species of secondary importance, such as *Acer rubrum*, *Prunus virginiana*, *Corylus cornuta*, *Ribes cynosbati*, *Ribes americanum*, *Sambucus racemosa*, *Lonicera canadensis*, *Taxus canadensis*, *Cornus rugosa*, *Viburnum acerifolium*, and *Parthenocissus quinquefolia*. A number of trees and shrubs occur here and there in mixed communities. Among these may be mentioned *Quercus alba*, *Quercus coccinea*, *Fragaria americana*, *Juniperus virginiana*, *Salix nigra*, *Sorbus americana*, *Ulmus racemosa*, *Prunus americana*, *Cornus alternifolia*, and *Cornus candidissima*. A few in this list were not seen by the writer, but were reported by Cass Andrews, of the Land Economic Survey, who spent several weeks on the island.

The herbaceous flora of the woodland areas shows affinities to that of both the southern and the northern districts of the Michigan mainland. The following are typical: *Thalictrum dioicum*, *Circaea latifolia*, *Hepatica acutiloba*, *Viola erocarpa*, *Polygonatum pubescens*, *Smilacina stellata*, *Caulophyllum thalictroides*, *Arisaema triphyllum*, *Solidago latifolia*, *Adiantum pedatum*, *Athyrium angustum*, *Thelypteris spinulosa* and var. *intermedia*, *Thelypteris Dryopteris*, *Pyrola secunda*, *Linnaea americana*, *Aralia nudicaulis*, *Mitchella repens*, and *Chimaphila umbellata* var. *cisatlantica*. The spurred gentian (*Halenia deflexa*) and also *Gentiana quinquefolia* were noticed in woodland clearings on Garden Island.

In the northern half of Big Beaver there is a comparatively large area of level sandy land broken up by scattered marshes and woods. This lies back of the sand dunes and occupies several square miles.

Over parts of the region the soil becomes dry during the warm season and supports a more or less xerophytic group of woody plants, such as *Prunus pennsylvanica*, *Shepherdia canadensis*, *Diervilla Lonicera*, and *Salix humilis*. Open woodland communities here are quite dry by September, but the presence of several species characteristic of mesophytic woodlands, such as *Hepatica triloba*, *Maianthemum canadense*, and *Trientalis borealis*, indicates considerable moisture in the spring or the early summer. With the drying out of the soil during the late summer and early fall conditions become more favorable to another group, comprising *Gaultheria procumbens*, *Arctostaphylos Uva-ursi* var. *coactilis*, *Melampyrum lineare*, *Campanula rotundifolia*, *Anaphalis margaritacea*, *Solidago juncea*, *Aster macrophyllus*, and *Aster laevis*. Where the ground has been originally cleared or burned over secondary successions (subseres) are coming in. Here the plant communities include *Vaccinium pennsylvanicum*, *Rubus allegheniensis*, *Rubus idaeus* var. *strigosus*, and *Rubus canadensis*. Typical of the more level areas are *Pteridium latiusculum*, *Potentilla argentea*, *Krigia virginica*, *Apocynum androsaemifolium*, *Aralia spinosa*, *Lithospermum canescens*, *Monarda fistulosa*, *Satureja vulgaris*, *Hieracium paniculatum*, *Gnaphalium decurrens*, and *Selaginella rupestris*, the last of which forms dense mats in places.

Plants representative of northern bogs are found in the wet soil bordering inland lakes and marshes. The total number of species is comparatively large. Woody vegetation includes two common trees, *Larix laricina* and *Fraxinus nigra*, and the following shrubs: *Chamaedaphne calyculata*, *Ledum groenlandicum*, *Betula pumila*, *Andromeda glaucophylla*, *Kalmia polifolia*, *Myrica Gale*, *Rosa palustris*, *Cornus stolonisfera*, *Aronia melanocarpa*, *Vaccinium canadense*, *Potentilla fruticosa*, *Ilex verticillata*, *Alnus incana*, *Viburnum cassinoides*, *Salix lucida*, *Salix discolor*, *Salix candida*, and *Salix pedicellaris*. A thorough survey of the herbaceous vegetation could not be made in the limited time at the disposal of the writer. The following list reflects more or less the time of year the observations were made: *Eupatorium maculatum*, *Aster puniceus*, *Bidens laevis*, *Solidago canadensis*, *Chelone glabra*, *Agalinis paupercula*, *Lysimachia terrestris*, *Potentilla palustris*, *Menyanthes trifoliata*, *Scutellaria epilobifolia*, *Scutellaria lateriflora*, *Hypericum virginicum*, *Lycopus uniflorus*, *Lobelia Kalmii*, *Geum strictum*, *Impatiens biflora*, *Viola lanceolata*, *Iris versicolor*, *Zygadenus chloranthus*, and *Carex Oederi* var. *pumila*; also the



aquatics, *Pontederia cordata*, *Nymphaea tuberosa*, *Eriocaulon septangulare*, and *Scirpus americanus*, and the fernworts, *Thelypteris palustris*, *Osmunda Claytoniana*, *Osmunda regalis* var. *spectabilis*, *Pteris nodulosa* (ostrich fern), and *Onoclea sensibilis*. Around the border of Egg Lake there is a typical sphagnum bog girdled by a floating mat, in which were noticed such characteristic plants as *Sarracenia purpurea*, *Drosera intermedia*, *Triglochin palustris*, *Rhynchospora alba*, *Rhynchospora capillacea*, and *Eriophorum virginicum*.

Considerable areas of peaty soil are occupied by "cedar swamps." Small individuals of white cedar (*Thuja occidentalis*) often stand so thick as to form an almost impenetrable barrier. Where windfalls occur, the characteristic species are *Clintonia borealis*, *Cornus canadensis*, *Mitella nuda*, *Coptis groenlandica*, *Galium triflorum*, and *Chiogenes hispida*.

The composition of the beach flora varies considerably, depending on the location. The character of the vegetation associated with the dunes paralleling the west shore has been well described by Fuller.<sup>4</sup> Besides *Agropyron dasystachyum*, mentioned by Fuller, *Elymus canadensis* and *Calamovilfa longifolia* occurred here and there sporadically. The two characteristic willows are *Salix adenophylla* and *Salix glaucophylla*, which are common along nearly all sandy shores of the Great Lakes. The surface of the beach ranges from fine sand to coarse gravel or shingle. Two of the interesting species seen in these gravels were the red anemone (*Anemone Hudsoniana*) and *Gentiana procera*, which occasionally formed striking patches of blue. The beach was also white here and there with "grass of Parnassus" (*Parnassia caroliniana*).

As already mentioned, a considerable number of introduced plants occur along roadsides and around settlements. Considering the fact that certain sections have been farmed for many years, one would expect to find some of the commoner grass and forage plants. Among those listed as weeds along roadsides were *Phleum pratense*, *Poa compressa*, *Poa pratensis*, *Melilotus alba*, and *Trifolium repens*. Such plants as *Sedum acre*, *Nepeta cataria*, *Inula helenium*, and *Rosa Eglanteria* have probably escaped from gardens. The majority of introductions, totaling at least sixty species, would be classed as weeds. Of these, the most serious from the agriculturist's viewpoint

<sup>4</sup> Fuller, G. D., "Some Perched Dunes of Northern Lake Michigan and Their Vegetation," *Trans. Illinois Acad. Sci.*, 11: 111-122, 1918.

would undoubtedly be *Agropyron repens*, *Daucus Carota*, *Cirsium arvense*, *Cirsium lanceolatum*, *Arctium minus*, and *Chrysanthemum Leucanthemum* (probably the variety *pinnatifidum*) Poison ivy (*Rhus Toxicodendron*) was seen growing in and along the borders of woods Water hemlock (*Cicuta bulbifera*) and water parsnip (*Sium suave*), both of which may poison cattle, occur in low wet ground

So far as the writer knows, the present paper is the first to outline the vegetational features of Beaver Island as they relate to the vascular plants Altogether, a total of 333 species was listed This includes a few from Garden Island None of the other islands was visited

In closing, the writer wishes to acknowledge his indebtedness to Mr L R A Schoenmann and Miss Helen Martin for certain information in regard to geological and phytographic features, and to express his appreciation to members of the Land Division of the Department of Conservation for the use of facilities in the construction of a map of the Beaver Islands

MICHIGAN STATE COLLEGE  
EAST LANSING, MICHIGAN

**PLATES I-III**



FIG 1 Fox Lake, in Sec 28, T 38 N, R 10 W (see map, Fig 1) The tree in the foreground is white pine (*Pinus Strobus*)



FIG 2 View from Mount Pisgah, looking northwest, showing High Island in the distance The open stretch to the right represents the approximate level of glacial Lake Nipissing The poplars in the foreground indicate the light character of the soil





A part of the sand-dune region northwest of Faunt Lake. Note clumps of low juniper (*Juniperus communis* var. *depressa*) on the left (see text, p 33)





FIG 1 Part of the inner shore of Beaver Harbor The soil here is a sandy loam, the dominant trees are white pine, red pine, and red oak



FIG 2 The King's Highway, looking south in the vicinity of St James (see text, p 32)





## ADDITIONS TO THE FLORA OF MICHIGAN. II

CLARENCE R. HANES

THE reports in the first section of this paper are based upon collections by Dr F J Hermann and represent additions to the flora of Washtenaw County. Those in the second part record species hitherto unknown from Kalamazoo County. They are recent collections and were made by Mrs Florence N Hanes and the writer unless otherwise stated. Specimens of all the plants have been deposited in the Herbarium of the University of Michigan or in the Gray Herbarium or in the National Herbarium, and duplicates have been incorporated in the collectors' herbaria.

Species marked with an asterisk are new to Michigan, so far as can be determined.

### LIST OF SPECIES

#### WASHTENAW COUNTY

- FESTUCA RUBRA** L. — Gravelly roadside, Arlington Boulevard, Sec 34, Ann Arbor Township, two and one-half miles southeast of Ann Arbor, May 17, 1938, *F J Hermann, 9424*
- POA LANGUIDA** Hitchc. — Rare, in open oak woods, Sec 13, Pittsfield Township, five and one-quarter miles southeast of Ann Arbor, May 12, 1938, *F J Hermann, 9411*
- POA PALUDIGENA** Fern & Wieg. — Infrequent in Thuja bog, Sec 31, Dexter Township, two and three-quarter miles northeast of Chelsea, May 30, 1938, *F J Hermann, 9463*, frequent on swampy border of Speechley's woods, Sec 35, Ann Arbor Township, two and three-quarter miles east of Ann Arbor, June 5, 1938, *F J Hermann, 9494*
- PANICUM LEIBERGII** (Vasey) Scribn. — Gravelly embankment bordering Michigan Central Railroad, Sec 27, Ann Arbor Township, two and three-quarter miles east of Ann Arbor, June 2, 1938, *F. J. Hermann, 9475*

The only Michigan record for this species in A. S. Hitchcock

and Agnes Chase's *North American Species of Panicum* (Contrib U S Nat Herb, 15:290 1910) is "Harsens Island, Lake St Clair, Dodge in 1899"

Walpole's report of *Panicum Ravenellii* from Washtenaw County (*Flora of Washtenaw County* [Ypsilanti, 1924], p 15) was probably based upon material of this species

**ELEOCHARIS CALVA** Torr — Extensive beds in marshy field, University of Michigan Botanical Gardens, Ann Arbor, June 20, 1938, *F J Hermann, 9501*

**CAREX HIRSUTELLA** Mack — Plentiful on low grassy edge of abandoned woodland road bordering Mud Lake bog south of Barker Road, Sec 1, Webster Township, one and three-quarter miles west of Whitmore Lake, June 1, 1938, *F J Hermann, 9470*

**CHENOPODIUM LEPTOPHYLLUM** Nutt — Frequent on clay roadside, Huron River Drive, Sec 35, Ann Arbor Township, three and one-half miles southeast of Ann Arbor, October 6, 1937, *F J Hermann, 9380*

**MITCHELLA REPENS** L — A small colony in open oak woods, Sec 13, Pittsfield Township, five and one-quarter miles southeast of Ann Arbor, May 12, 1938, *F J Hermann, 9413*

#### KALAMAZOO COUNTY AND VICINITY

**\*BROMUS SQUARROSUS** L — Right-of-way of the branch of the New York Central lines, two miles northeast of Schoolcraft, June 9, 1938, *F W Rapp, 688*

The writer collected specimens on June 9, 1938 Mr Rapp, of Vicksburg, had found it the previous season Mrs Agnes Chase, of the National Herbarium, states that there are no reports of this species from the United States In the second edition of Britton and Brown's *Illustrated Flora of North America* it is given as occurring around Atlantic seaports

**HOLCUS LANATUS** L — Wooded border of swamp near highway in Prairie Ronde Township, four and one-half miles southwest of Schoolcraft, July 11, 1938, *908*

This grass is given in P. E. Herbert's list of the plants for Berrien County<sup>1</sup> So far as is known, there are no other records for the state

<sup>1</sup> "Ferns and Flowering Plants of Berrien County, Michigan," *American Midland Naturalist*, 15:325 1934.

**RHYNCHOSPORA FUSCA** (L.) Ait f — Sphagnum swamp one-fourth mile west of West Lake, Aug 16, 1938, 2278

The only station for Michigan listed in Dr Beal's "Michigan Flora" is Escanaba

In Kalamazoo County this plant thrives in a sphagnum bog several acres in extent Over a large part of the bog it is the dominant species

\***CAREX HOWEI** Mack (*C. scirpoides* var *capillacea* of Gray's Manual, Seventh Edition) — On the south border of Goose Lake, June 12, 1934, 1244, in Section 32, Prairie Ronde Township, May 29, 1936, 666, in wooded swamp in Section 34, Schoolcraft Township, June 25, 1938, 1298

According to Dr Hermann these are the only authenticated records for the state

**CAREX UMBELLATA** Schkuhr (*C. umbellata* var *brevirostris* of Gray's Manual, Seventh Edition) — Near the right-of-way of the Grand Trunk Western Railroad three miles east of Schoolcraft, June 4, 1937, 2897

It is interesting to note that the only other station for this sedge is on the Keweenaw Peninsula

\***CAREX OLIGOCARPA** Schkuhr — In a maple wood called the "Sugar-bush" one-half mile west of the village of Schoolcraft, June, 1933, 1243

According to Dr Hermann, other Michigan collections in herbaria purporting to be *Carex oligocarpa* proved to be *Carex Hitchcockiana* Dewey

**CAREX STRICTA** Lam — Growing in large clumps in a boggy swamp in the northwestern part of St Joseph County, within a few rods of the Kalamazoo County line, May 7, 1938, 3849

Like *Carex umbellata*, this sedge is limited in its Michigan range, having been collected elsewhere only on the Keweenaw Peninsula and on Isle Royale

\***TRADESCANTIA BRACTEATA** Small — In very light sand, north-east of Bradley, Allegan County, June 17, 1938, Gilbert Becker, 3867

Dr. Edgar Anderson, of the Missouri Botanical Garden, has confirmed the determination of this species. The plants were scattered in good-sized patches over more than an acre of ground

It may be adventive or an escape, since this station is distant from its usual range

\***PLAGIOBOTHRYX HIRTUS** (Greene) Johnston var **FIGURATUS** (Piper) Johnston — On the border of low ground in a field one mile southwest of Schoolcraft, July 27, 1938, 118.

According to Dr I M Johnston, of the Arnold Arboretum, this is a plant of Oregon and Washington west of the Cascades. The only other report of the species east of the Cascades is from Ludlow, Missouri, 1937

It is uncertain whether the plant was introduced with alfalfa seed or in stock litter, since the Grand Trunk Western Railroad runs alongside this field

SCHOOLCRAFT, MICHIGAN

## RECORDS FOR THE GRAMINEAE OF THE DOUGLAS LAKE REGION, MICHIGAN\*

LEROY HATFIELD HARVEY

**D**URING the summers of 1937 and 1938 the author collected grasses in Cheboygan, Emmet, and Presque Isle counties, Michigan. This collecting and that of Dr. John H. Ehlers over several summers (1932-38) in the same area have resulted in the following additions to the flora of the Douglas Lake region: nine species from Cheboygan County, four from Emmet County, and two from Presque Isle County. Among the number are three species, one from the Lower Peninsula, that seem to be previously unreported from the state.

The author is indebted to Dr. Ehlers for his kind permission to incorporate unpublished records of his in this paper and to Mrs. Agnes Chase and Mr. Jason R. Swallen of the United States National Herbarium for verification of some identifications.

### CHEBOYGAN COUNTY

#### *Agrostis palustris* Huds.

Found in 1935 by Dr. Ehlers, it was growing on the Cheboygan dump, where it has since maintained itself (Ehlers 5841, Harvey 502, 1937). It was probably introduced there in cuttings from lawns, for it is one of the commonly used lawn grasses.

#### *Bromus tectorum* L.

Introduced and spread in Cheboygan County by the railroads. It is now found mostly along the tracks near railroad stations, but is spreading along the roads in the county. Collected at Topinabee in 1937 (Harvey 519).

\* Papers from the Department of Botany and Herbarium of the University of Michigan, No. 690.

*Calamovilfa longifolia* (Hook ) Scribn

Found sparingly on the dunes of Duncan Bay (Harvey 427, 1937) It was to be expected there, since it occurs along the lake shores on both sides of the county

*Elymus virginicus* L

Locally common in a wet depression in the aspens north of Tower (Harvey 239, 1937) It is found in Emmet County, adjoining, and the habitat is typical, so that the extension is not a surprise

*Eragrostis poaeoides* Beauv

Abundant in 1937 along the Michigan Central Railroad in front of every station in the county In 1938 it had apparently been completely destroyed by weeding This is a typical illustration of the distribution of plants by railroads Collected at Mackinaw City in the railroad yards (Harvey 543)

*Festuca octoflora* Walt

Found by Dr Ehlers in 1934 along a path at the University of Michigan Biological Station at Douglas Lake, it has been slowly spreading since that time (Ehlers 5565, Harvey 600, 1938). It was probably introduced from farther west in mud carried by automobiles

*Lohum temulentum* L

First reported from Michigan by Wright (1839) His specimens are in the University of Michigan Herbarium, but search has failed to show any collection of this species from Michigan by him or by anyone else The plant occurred in the Cheboygan dump intermixed with clumps of the next species (Harvey 671a, 1938)

*Phalaris canariensis* L

Abundant along the swampy edge of the Cheboygan dump in the summer of 1938 (Harvey 671) This as well as the last species may have been introduced in cleanings from cages of canaries, for it yields the canary seed of commerce

*Sporobolus cryptandrus* (Torr ) A Gray

Common in a strip along the Cheboygan-Mackinaw City road (U. S -23) three to seven miles below Mackinaw City (Harvey 504,

1937) It was probably introduced in straw used to protect fresh concrete from damage by frost when the road was being built or in grass seed sown to bind the shoulder of the road

## EMMET COUNTY

*Beckmannia syzigachne* (Steud.) Fernald

Found by Dr Ehlers in the summer of 1932 along the border of a small stream flowing into the Crooked River at Alanson (Ehlers 5112) It has not since been noted there or elsewhere in the area. It may have been a relict of a wider distribution in this state, since it is found in Wisconsin and Illinois. It has not been reported from Michigan before.

*Brachyelytrum erectum* (Schreb.) Beauv

Common in moist woods along the Carp Lake River (Harvey 418, 1937). The habitats of this and the two following species were typical and well within their known ranges.

*Leersia oryzoides* (L.) Swartz

Common in moist sand along the banks of the Crooked River below Alanson (Harvey 510, 1937).

*Panicum tsugetorum* Nash

Widespread on old vegetated sand dunes southeast of Sturgeon Bay (Harvey 683, 1938).

*Phragmites communis* Trin

An interesting form of this species, found on the flats of Cecil Bay in 1937 (Harvey 492), produces long superficial stolons, which apparently start out as rhizomes but are forced to the surface because of the saturation of the soil. These root at the nodes and bear apparently sterile culms there and at the tips. Stolons forty-three feet long were found at this location. The same form has been seen, but not collected, at Sugar Loaf Lake in Kalamazoo County.

## PRESQUE ISLE COUNTY

*Muhlenbergia uniflora* (Muhl.) Fernald

Collected in 1936 by Dr. Ehlers (6160) along the swampy shores of Lake 16,<sup>1</sup> but not reported from the Lower Peninsula. It was

<sup>1</sup> For a description of this station see Hermann (1936)



found in a typical habitat and well within the known range of the species

*Panicum spretum* Schult

Common along the swampy edge of Lake 16, where it was collected by Dr Ehlers in 1936 (6161) and by the author in 1938 (665) It is new for Michigan records and is about 450 miles from the nearest known station, on the dunes near Michigan City, Indiana These two localities are the only ones known in the Middle West, the continuous range is along the Atlantic and Gulf coasts The discovery adds another typical coastal plain species to the flora of this region

UNIVERSITY OF MICHIGAN

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## LICHENS OF NORTHERN MICHIGAN \*

JOYCE HEDRICK

PRINTED records of northern Michigan lichens are few. In 1925 G. E. Nichols (9) published an extensive list from material collected in the Douglas Lake region in the northern part of the Lower Peninsula. H. T. Darlington in 1931 (3) and 1938 (4) gave the results of his and Dr. Bessey's collecting in the Porcupine Mountains. A few records are to be found in earlier papers by Bogue (1), Dachnowski (2), Fink (5), and Ruthven (10). Some additional ones are in Fink's *Lichen Flora of the United States* (6). A paper on the lichens of Isle Royale by the author and J. L. Lowe (7) and another one by Lowe (8) complete the present knowledge of the lichen flora of the area, which seems to be similar to that of neighboring regions.

The specimens upon which this report is based were gathered by J. L. Lowe during June, 1933, in the region of Munising and Marquette in northern Michigan. Some collections were made by A. H. Smith, who, with Mr. Lowe, was a guest of Dr. and Mrs. E. B. Mains during that time. More than one thousand specimens were obtained. All but those belonging to the family Lecideaceae, which are being studied by Mr. Lowe, are listed here.

The plants were collected in the burns and on the shore-line rocks of Lake Superior. The burns, as the term implies, had been swept by fire and now consist mostly of a scattered growth of aspen and other small trees, and have a rather sparse ground cover. The shore line at Laughing Whitefish Point, Deerton, is low and rocky near the lake, with cliffs rising to 10 and 15 feet farther back, whereas Sugarloaf Mountain, Marquette, rises abruptly to a height of about 500 feet above the water.

The material represents 59 genera in 26 families. The number of genera will be increased when the study of the Lecideaceae is completed. The Isle Royale list gives 60 genera in the same 26 families. Nichols reports 46 genera in 24 families. The present paper consists

\* Papers from the Herbarium of the University of Michigan.

of 226 species and subspecies Nichols gives 155, the Isle Royale publication, 296, and Darlington, 73

In this paper 15 species and 4 subspecies are reported for the first time in the state, but have been recorded from one or more neighboring regions For convenience in future study species and subspecies new to the records are starred in the list The collector's numbers are those of J L Lowe unless otherwise stated

### LIST OF SPECIES

#### VERRUCARIACEAE

- \**STAUROTHELE UMBRINA* (Ach) Tuck — On rock face in gully, Sugarloaf Mountain, Marquette, 2306

#### DERMATOCARPACEAE

- DERMATOCARPON MINIATUM* var. *COMPLICATUM* (Leight) T Fries — On rocks of slope, near Bald Mountain, Big Bay, 2130

#### PYRENULACEAE

- LEPTORHAPHIS EPIDERMIS* (Ach) T Fries — On white birch, Rock River, 1796, 2235, on dead birch along shore, Laughing Whitefish Point, Deerton, 1929
- PYRENULA FARREA* (Ach) Branth & Rostr — On aspen in burn, Rock River, 2205, 2229
- PYRENULA NITIDA* (Weig) Ach. — On beech between Au Train Lake and Au Train Falls, Au Train, 1555, 1567, on trees along shore, Au Train Lake, Au Train, 2103 (Smith)

#### CALICIACEAE

- CHAENOTHECA CHRYSOCEPHALA* (Turn) T Fries — On hemlock in woods, Onota, 1867, on spruce and cedar in swamp, Laughing Whitefish Point, Deerton, 2525, 2534.
- CHAENOTHECA BRUNNEOLA* (Ach) Müll Arg — On cedar log in woods, Wagner's Falls, Munising, 2033
- CHAENOTHECA TRICHIALIS* (Ach) T Fries — On cedar below falls, Wagner's Falls, Munising, 1762; on cedar in bog, Rock River, 1826
- \**CALICIUM LENTICULARE* (Hoffm.) E Fries — On conifer stub along shore, Laughing Whitefish Point, Deerton, 1950a

\**CALICIUM TRACHELINUM* Ach — On cedar, Au Train Lake, Au Train, 2197

\**CALICIUM PUSILLUM* (Ach) Floerke — On roots of old stump, Onota, 1859, on under side of stump in woods, Laughing Whitefish Point, Deerton, 2544

*MYCOCALICIUM PARIETINUM* (Ach) Vainio — On trees and stumps, Au Train Lake, Au Train, 1573, 1579, 2067, 2199, 2200; on cedar in swamp, Rock River, 1830, on conifer stub along shore, Laughing Whitefish Point, Deerton, 1950

*CONIOCYBE FURFURACEA* (L) Ach — On soil and roots of upturned tree, Wagner's Falls, Munising, 1750, 2048, on roots of old tree, Onota, 1857, under rocks in burn and on roots of upturned stump along shore, Laughing Whitefish Point, Deerton, 2497, 2563

*STENOCYBE MAJOR* Nyl — On balsam in woods, Au Train Lake, Au Train, 2086

*SPRINCTRINA GELASINATA* (With) Zahlbr — On fallen dead maple between Au Train Lake and Au Train Falls, Au Train, 1577a

#### CYPHELIACEAE

*CYPHELIUM TIGILLARE* Ach — On trees along shore and stumps in burn, Laughing Whitefish Point, Deerton, 2483, 2558

#### ARTHONIACEAE

*ARTHONIA DIFFUSELLA* Fink — On cedar along shore, Au Train Lake, Au Train, 2065

*ARTHONIA RADIATA* (Pers) Ach — On basswood bark, Onota, 1860, on alder in swamp, Wagner's Falls, Munising, 2052.

#### GRAPHIDACEAE

*OPEGRAPHA VARIA* Pers — On beech, Miner's Falls, Munising, 1666, 1667, 1668, on beech in woods, Chatham, 1620; on maple in woods, Rock River, 1780; on cedar along shore, Au Train Lake, Au Train, 2071; on cedar in swamp, Laughing Whitefish Point, Deerton, 2533

*OPEGRAPHA VIRIDIS* Pers. — On balsam in woods, Miner's Falls, Munising, 1687

\**MELASPILEA ARTHONIOIDES* (Fée) Nyl — On maple in woods, Rock River, 1782

*GRAPHIS SCRIPTA* (L.) Ach — On maple in woods, Onota, 1866; on alder in swamp, Wagner's Falls, Munising, 2050

*GRAPHIS SCRIPTA* var *RECTA* (Schaer) Rabenh — On birch in woods, Miner's Falls, Munising, 1671.

#### DIPLOSCISTACEAE

*CONOTREMA URCEOLATUM* (Ach.) Tuck — On hard maple, between Au Train Lake and Au Train Falls, Au Train, 1580, on maple in woods, Rock River, 1779, on branches of fallen tree, Onota, 1871

*URCEOLARIA SCRUFOSA* (Schreb.) Ach — On rocks facing the lake, and in gully, Sugarloaf Mountain, Marquette, 2252, 2284

#### GYALECTACEAE

*MICROPHIALE DILUTA* (Pers.) Zahlbr — On very moist leaves in woods, Miner's Falls, Munising, 1697

#### COLLEMACEAE

\**SYNECHOBLASTUS NIGRESCENS* (Huds.) Trev — On maple log in woods, Chatham, 1605

\**SYNECHOBLASTUS RUPESTRIS* (Swartz) Trev — On trees, Au Train Falls, Au Train, 1585

*COLLEMA FURVUM* (Ach.) DC — On rocks along shore, Sugarloaf Mountain, Marquette, 2331a

*COLLEMA FLICATILE* Ach — On rocks along shore, Laughing Whitefish Point, Deerton, 1890, 2444

*LEPTOGIUM TREMELLOIDES* (L.) S. F. Gray — At base of tree, Au Train, 1553, on rocks along shore, Laughing Whitefish Point, Deerton, 2011; at base of rocks, near Bald Mountain, Big Bay, 2117

#### PANNARIACEAE

*PARMELIELLA MICROPHYLLA* (Swartz) Müll. Arg — On rocks along shore, Laughing Whitefish Point, Deerton, 1992; on soil and rocks, near Bald Mountain, Big Bay, 2121a, 2154

*PANNARIA PEZIZOIDES* (Weber) Trev — On rocks along shore, Rock River, 2380

*PANNARIA LEUCOSTICTA* Tuck — On rocks, near Bald Mountain, Big Bay, 2121; on rocks in gully, Sugarloaf Mountain, Marquette, 2286, on rocks along shore, Laughing Whitefish Point, Deerton, 2469.

- \**PARMARIA RUBIGINOSA* var *CONOPHAEA* (Pers) Koerb — On moss over rocks in gully, Sugarloaf Mountain, Marquette, 2310

## STICTACEAE

- STICTA AMPLISSIMA* (Scop) Rabenh — On ash in swamp, Au Train, 1554

- STICTA PULMONARIA* (L) Bir — On maple log in woods, Chatham, 1606

## PELTIGERACEAE

- SOLORINA SACCATA* (L) Ach — On moss wet by spray, Miner's Falls, Munising, 1674

- SOLORINA SACCATA* var *SPONGIOSA* (J E Smith) Nyl — On moss wet by spray, Miner's Falls, Munising, 1674a

- NEPHROMA HELVETICUM* Ach — On rock face, near Bald Mountain, Big Bay, 2118

- NEPHROMA TOMENTOSUM* (Hoffm) Flot — On soil over rocks, near Bald Mountain, Big Bay, 2178a

- NEPHROMA LAEVIGATA* Ach — At base of maple in woods, Onota, 1865, on soil over rocks, near Bald Mountain, Big Bay, 2178

- NEPHROMA LAEVIGATA* f *PARILE* (Ach) Mudd — On moss over rocks in burn, Laughing Whitefish Point, Deerton, 1971, 2014, on moss on cliff and in gully, Sugarloaf Mountain, Marquette, 2273, 2287

- PELTIGERA APHTOSA* (L) Willd — On soil with moss, Au Train Falls, Au Train, 1596, on old stump in woods, Wagner's Falls, Munising, 2045

- PELTIGERA HORIZONTALIS* (Huds) Baumg — On moss-covered log, Au Train Falls, Au Train, 1588, on moss along shore and in woods, Laughing Whitefish Point, Deerton, 1948, 2508

- PELTIGERA POLYDACTYLA* (Neck) Hoffm — On log near stream, Miner's Falls, Munising, 1689, on moss over rocks in woods, Rock River, 1854, on cliff facing the lake, Sugarloaf Mountain, Marquette, 2275, 2282

- PELTIGERA SCUTATA* (Dick) Duby — On soil over rocks along shore, Laughing Whitefish Point, Deerton, 2000, on cedar along shore, Au Train Lake, Au Train, 2081

- PELTIGERA MALACEA* (Ach.) Funck — On soil over rocks along shore, Laughing Whitefish Point, Deerton, 2001; on rocks along shore, Rock River, 2373

- PELTIGERA RUFESCENS** (Weis ) Humb — On soil over rocks along shore, Laughing Whitefish Point, Deerton, 1927, 1991, 2002; on rocks of cliff facing the lake, Sugarloaf Mountain, Marquette, 2274
- PELTIGERA RUFESCENS** f **SOREDIATA** Oliv — Over moss, Au Train Falls, Au Train, 1587, on rocks facing the lake, Sugarloaf Mountain, Marquette, 2258
- PELTIGERA PRAETEXTATA** (Sommerf ) Vainio — On moss over log, Au Train Falls, Au Train, 1588a, on moss along shore, Laughing Whitefish Point, Deerton, 1947; on moss wet by spring in rock face, Sugarloaf Mountain, Marquette, 2294
- PELTIGERA CANINA** (L ) Willd — On moss along shore, Laughing Whitefish Point, Deerton, 1946, on moss-covered log in woods, Wagner's Falls, Munising, 2046, on soil over rocks, near Bald Mountain, Big Bay, 2160
- PELTIGERA SPURIA** (Ach ) DC — On soil in burn, Laughing Whitefish Point, Deerton, 1932

## LECIDEACEAE

- LECIDEA GRANULOSA** (Hoffm ) Ach — On old wood on sand bank, Lake Superior shore, west of Au Train, 1642, 1643, 1649, 1655, on sand in burn, Rock River, 1799; on soil in burn, Laughing Whitefish Point, Deerton, 1962
- MYCOBLASTUS SANGUINARIUS** (L ) Norm — On hemlock log, Au Train Falls, Au Train, 1590
- BACIDIA INUNDATA** (E Fries) Koerb — On rocks along shore, Laughing Whitefish Point, Deerton, 2466
- BACIDIA LUTEOLA** (Schrader ) Mudd. — On beech, Chatham, 1621
- BACIDIA SCHWEINITZII** (Tuck ) Schneid — On cedar, Au Train Falls, Au Train, 1581, 1586
- BACIDIA SUFFUSA** (E Fries) Schneid — On ash in woods, Chatham, 1635
- LOPADIUM PEZIZOIDEUM** (Ach ) Koerb. — On cedar below falls, Wagner's Falls, Munising, 1763
- \***RHIZOCARPON ALBOATRUM** (Hoffm ) Anzi — On rocks along shore, Laughing Whitefish Point, Deerton, 1937
- \***RHIZOCARPON GRANDE** (Floerke) Arn — On rocks along shore, Laughing Whitefish Point, Deerton, 1988a, on rocks, near Bald Mountain, Big Bay, 2169, 2172.

\**RHIZOCARPON LECANORINUM* (Koerb) Anders — On rocks, near Bald Mountain, Big Bay, 2190, on rocks, top of Sugarloaf Mountain, Marquette, 2299

*RHIZOCARPON GEOGRAPHICUM* (L) Lam & DC — On rocks, near Bald Mountain, Big Bay, 2109, 2166, 2190a, on rocks along shore, Sugarloaf Mountain, Marquette, 2335b, 2337

CLADONIACEAE

*BABOMYCES RUFUS* (Huds) Rebert — On granite rocks in woods, Onota, 1853

*CLADONIA RANGIFERINA* (L) Web — On sand, Lake Superior shore, west of Au Train, 1651

*CLADONIA SYLVATICA* (L) Hoffm — On sand, Lake Superior shore, west of Au Train, 1650, on moss-covered log, Miner's Falls, Munising, 1696, on fallen birch in woods, Rock River, 1795

*CLADONIA ALPESTRIS* (L) Rabenh — On sand ridge, Rock River, 1810, on soil over rocks, near Bald Mountain, Big Bay, 2186

*CLADONIA FLOERKEANA* (E Fries) Sommerf — On old stump in burn, Rock River, 2221

*CLADONIA BACILLARIS* (Del) Nyl — On old wood, Lake Superior shore, west of Au Train, 1647, on soil over rocks in burn, Laughing Whitefish Point, Deerton, 1956, on exposed rocks, Sugarloaf Mountain, Marquette, 2238

\**CLADONIA MACILENTA* Hoffm — On sand and old wood, Lake Superior shore, west of Au Train, 1646, 1647a, on old wood in burn, Laughing Whitefish Point, Deerton, 1965, at base of tree, near Bald Mountain, Big Bay, 2148, on soil over rocks, Sugarloaf Mountain, Marquette, 2238a

*CLADONIA MACILENTA* var *SQUAMIGERA* Vainio — On ledge facing the lake, Sugarloaf Mountain, Marquette, 2264

*CLADONIA DIGITATA* Hoffm. — On old stump in woods and on sand ridge, Rock River, 1770, 1874

*CLADONIA COCCIFERA* (L) Willd — On soil over rocks, near Bald Mountain, Big Bay, 2162; on soil over rocks, Sugarloaf Mountain, Marquette, 2257

*CLADONIA COCCIFERA* var *PLEUROTA* (Floerke) Schaer — On soil over rocks near shore, Laughing Whitefish Point, Deerton, 1953.

*CLADONIA DEFORMIS* (L) Hoffm. — On sand and old wood, Lake



- Superior shore, west of Au Train, 1640, on moist rotten log and sand ridge, Rock River, 1767, 1809
- CLADONIA CRISTATELLA* Tuck — On soil over rocks near shore, Laughing Whitefish Point, Deerton, 1952
- CLADONIA CRISTATELLA* var *VESTITA* Tuck — On old log in burn, Wagner's Falls, Munising, 2502
- CLADONIA AMAUROCRAEA* (Floerke) Schaer — On soil over rocks of cliff, Sugarloaf Mountain, Marquette, 2277, on soil in burn, Rock River, 2223
- CLADONIA UNCIALIS* (L.) Hoffm — On sand, Lake Superior shore, west of Au Train, 1654, on soil in burn, Laughing Whitefish Point, Deerton, 1984, on soil over rocks, near Bald Mountain, Big Bay, 2185
- CLADONIA FURCATA* (Huds.) Schrad — On soil over rocks, near Bald Mountain, Big Bay, 2126
- CLADONIA FURCATA* f. *PARADOXA* (Vainio) Fink — On sand ridge, Rock River, 1812, 1842
- CLADONIA FURCATA* var *RACEMOSA* (Hoffm.) Floerke — On soil in burn, Rock River, 2225
- CLADONIA FURCATA* var *SCABRIUSCULA* (Del.) Vainio. — On soil over rocks, near Bald Mountain, Big Bay, 2114, 2193
- CLADONIA MULTIFORMIS* Merrill — On old stump in burn, Rock River, 2226
- CLADONIA CRISPATA* (Ach.) Flot — On soil on sand ridge and in burn, Rock River, 1847, 2203
- CLADONIA CRISPATA* var *DIVULSA* (Del.) Arn — On rotten log, Miner's Falls, Munising, 1704, on sand ridge, Rock River, 1807, 1808
- CLADONIA CRISPATA* var *INFUNDIBULIFERA* (Schrad.) Vainio — On old wood, Lake Superior shore, west of Au Train, 1641; on soil in burn and along shore, Rock River, 2224, 2374
- CLADONIA CRISPATA* var *VIRGATA* (Ach.) Vainio — On sand, Lake Superior shore, west of Au Train, 1653
- CLADONIA SUBCRISPATA* Nyl — On rocks along road, Chatham, 1625, on soil in burn, Laughing Whitefish Point, Deerton, 1973.
- CLADONIA SQUAMOSA* (Scop.) Hoffm — On soil over rocks, near Bald Mountain, Big Bay, 2122, 2156; on soil in burn and on old logs and stumps in woods and along the river, Rock River, 1771, 1801,

2228, 2232; on old log in swamp, Laughing Whitefish Point, Deerton, 2526, 2527

*CLADONIA SQUAMOSA* var *PHYLLOCOMA* (Rabenh ) Vainio — On soil over rocks, near Bald Mountain, Big Bay, 2133, 2179, on soil over rocks facing the lake, Sugarloaf Mountain, Marquette, 2255, on stump in woods, Laughing Whitefish Point, Deerton, 2547

*CLADONIA SQUAMOSA* f *SQUAMOSISSIMA* Floerke. — On old stump in bog, Rock River, 1827

*CLADONIA CAESPITICIA* (Pers ) Floerke — On moss over rocks along shore, Rock River, 2386

*CLADONIA DELICATA* (Ehrh ) Floerke — On old log in burn, Rock River, 2220

*CLADONIA CENOTEA* (Ach ) Schaer — On old stump and soil, Rock River, 1772, 1875, on soil over rocks along shore, Laughing Whitefish Point, Deerton, 1961

*CLADONIA TURGIDA* (Ehrh ) Hoffm — On sand ridge, Rock River, 1813; on soil over rocks along shore and in woods, Laughing Whitefish Point, Deerton, 1955, 2019, on soil over rocks, near Bald Mountain, Big Bay, 2132

*CLADONIA CARIOSA* (Ach ) Spreng — On soil over rocks along shore and in burn, Laughing Whitefish Point, Deerton, 1910, 2027

*CLADONIA DECORTICATA* (Floerke) Spreng — On soil over rocks, near Bald Mountain, Big Bay, 2110, 2163, 2194

*CLADONIA GRACILIS* (L.) Willd — On rotten log in woods, Rock River, 1787

*CLADONIA GRACILIS* var *DILATATA* (Hoffm ) Vainio — On sand, Lake Superior shore, west of Au Train, 1661 (Smith), on old stump on sand ridge, Rock River, 1846, on old log, Au Train Lake, Au Train, 2399

*CLADONIA GRACILIS* var. *DILATATA* f *ANTHOCEPHALA* (Floerke) Sandst — On stump in swamp, Au Train, 1552, on old wood in sand pit along road, Chatham, 1609, on moss-covered log in woods, Miner's Falls, Munising, 1694

*CLADONIA CORNUTA* (L.) Schaer — On sand and on rock ledge along shore and on soil and old stumps in burn, Rock River, 1843, 1852, 2207, 2371, 2394, on stumps on point and on soil over rocks in burn, Laughing Whitefish Point, Deerton, 1876a, 2013a, on rocks facing the lake, Sugarloaf Mountain, Marquette, 2256.

- CLADONIA CORNUTA* var *PHYLLOTOCA* (Floerke) Arn — On sand ridge, Rock River, 1811, on soil over rocks in burn and on humus in woods, Laughing Whitefish Point, Deerton, 1972, 2025
- CLADONIA DEGENERANS* (Floerke) Spreng — On soil over rocks, near Bald Mountain, Big Bay, 2116, on rock ledge along shore, Rock River, 2372b
- CLADONIA DEGENERANS* f *CLADOMORPHA* (Ach) Vainio — On soil over rocks, near Bald Mountain, Big Bay, 2115
- CLADONIA DEGENERANS* f *EUPHOREA* (Ach) Floerke. — On rock ledge along shore, Rock River, 2372, on soil in burn, Laughing Whitefish Point, Deerton, 2405
- CLADONIA DEGENERANS* f *PHYLLOPHORA* (Ehrh) Floerke — On soil over rocks, near Bald Mountain, Big Bay, 2112, on soil in burn, Rock River, 2210
- CLADONIA DEGENERANS* f *POLYPAEA* Ach — On soil in burn, Rock River, 2209
- CLADONIA VERTICILLATA* Hoffm — In sand pit, Chatham, 1610, on soil over rocks in burn, Laughing Whitefish Point, Deerton, 2016, on soil over rocks, near Bald Mountain, Big Bay, 2113, on rock ledge along shore, Rock River, 2372a
- CLADONIA PYXIDATA* (L) Hoffm — On moss over rocks in burn, Laughing Whitefish Point, Deerton, 1951
- CLADONIA PYXIDATA* var *CHLOROPHAEA* (Spreng) Floerke — At base of tree in woods and on moss-covered log, Miner's Falls, Munising, 1669, 1693, on soil over rocks, near Bald Mountain, Big Bay, 2128, on old log along river, Rock River, 2230, on moss over rocks along shore, Laughing Whitefish Point, Deerton, 2458
- CLADONIA PYXIDATA* var *POCILLUM* (Ach) Flot — On sand, Lake Superior shore, west of Au Train, 1652
- CLADONIA FIMBRIATA* var *SIMPLEX* (Weiss) Flot — On soil over rocks in burn, Laughing Whitefish Point, Deerton, 1958; on soil in burn, Rock River, 2395
- CLADONIA FIMBRIATA* var *CORNUTORADIATA* Coem. — On stump on point, Laughing Whitefish Point, Deerton, 1876
- CLADONIA FIMBRIATA* var *SUBULATA* (L) Vainio — On soil over rocks along shore and in burn, Laughing Whitefish Point, Deerton, 1911, 2013, on soil over rocks, near Bald Mountain, Big Bay, 2146, on old log along river, Rock River, 2231

- CLADONIA FIMBRIATA** var **NEMOXYMA** (Ach.) Vainio — On soil over rocks, near Bald Mountain, Big Bay, 2155
- CLADONIA FIMBRIATA** var **CONIOCRAEA** (Floerke) Vainio — On moss-covered log below falls, Wagner's Falls, Munising, 1756, 1757, on old stump in woods, Rock River, 1768, 1789, on soil over rocks in burn, Laughing Whitefish Point, Deerton, 1957, on soil over rocks, near Bald Mountain, Big Bay, 2182
- \***CLADONIA FIMBRIATA** var **OCHROCHLORA** (Floerke) Vainio — On moss-covered log in woods, Wagner's Falls, Munising, 1764, on old stump in woods, Rock River, 1769, 1793
- CLADONIA BOTRYTES** (Hag.) Willd. — On pine cone, Lake Superior shore, west of Au Train, 1641 (Smith), on old log and stump in burn, Rock River, 1797, 2227, on old wood and bark, near Bald Mountain, Big Bay, 2103, 2111, on old wood in burn, Laughing Whitefish Point, Deerton, 2028, on soil on ledge, Sugarloaf Mountain, Marquette, 2512
- STEREOCAULON PASCHALE** (L.) Hoffm. — On soil in burn, Laughing Whitefish Point, Deerton, 2029, on rocks, near Bald Mountain, Big Bay, 2125, 2183, 2184
- STEREOCAULON TOMENTOSUM** E. Fries — On rock along roadside, Chatham, 1624, on rock in burn, Laughing Whitefish Point, Deerton, 1964

**GYROPHORACEAE**

- GYROPHORA HYPERBOREA** Ach. — On exposed rocks, Miner's Castle, Munising, 1733, on rocks along shore, Laughing Whitefish Point, Deerton, 1999, on rocks, near Bald Mountain, Big Bay, 2139.
- GYROPHORA DEUSTA** (L.) Ach. — On rocks in gully and along shore, Sugarloaf Mountain, Marquette, 2301a, 2338a
- GYROPHORA MÜHLENBERGII** Ach. — On rocks along shore, Laughing Whitefish Point, Deerton, 2017, on rocks, near Bald Mountain, Big Bay, 2158; on exposed rocks, Sugarloaf Mountain, Marquette, 2339 (Smith), 2510
- GYROPHORA VELLEA** (L.) Ach. — On exposed rocks, Sugarloaf Mountain, Marquette, 2240a
- GYROPHORA DILLENII** (Tuck.) Müll. Arg. — On rocks, near Bald Mountain, Big Bay, 2159, on exposed rocks, Sugarloaf Mountain, Marquette, 2240, 2338 (Smith).
- \***UMBILICARIA FUSTULATA** (L.) Hoffm. — On rocks, near Bald Mountain, Big Bay, 2176

## ACAROSPORACEAE

- \**ACAROSPORA CERVINA* (Ach.) Mass — On rocks, Laughing Whitefish Point, Deerton, 1892, 2447, 2493; on rocks facing the lake, Sugarloaf Mountain, Marquette, 2245, 2335a
- \**ACAROSPORA FUSCATA* (Schröd.) Arn — On exposed rocks, Miner's Castle, Munising, 1719, on rocks along shore and in burn, Laughing Whitefish Point, Deerton, 1986, 2005, 2008, 2012, 2556, on rocks, near Bald Mountain, Big Bay, 2142, 2173, 2192, on rocks, Sugarloaf Mountain, Marquette, 2246, 2290, 2325, 2335
- ACAROSPORA GLAUCOCARPA* (Ach.) Koerb — On rocks along shore, Sugarloaf Mountain, Marquette, 2320, 2328, on rocks along shore, Laughing Whitefish Point, Deerton, 2434

## PERTUSARIACEAE

- PERTUSARIA MULTIPUNCTA* (Turn.) Nyl — On ash in woods, Chatham, 1636, on beech, Au Train, 1566, on old log in woods, Wagner's Falls, Munising, 2032, on cedar in swamp, Laughing Whitefish Point, Deerton, 2536
- PERTUSARIA VELATA* (Turn.) Nyl — On ash in woods, Chatham, 1637, on aspen on sand ridge and rocks along lake shore, Rock River, 1838, 1844, 2387, 2388, on rocks along shore and on maple in woods, Laughing Whitefish Point, Deerton, 1995, 2015, 2475, on sandstone in woods, Onota, 1858
- PERTUSARIA LEIOPLACA* (Ach.) Lam & DC — On living maple, Au Train, 1558, 1561, on birch, Miner's Falls, Munising, 1672, on maple in gully, Sugarloaf Mountain, Marquette, 2291
- PERTUSARIA PERTUSA* (L.) Tuck — On fallen dead maple, Au Train, 1577, on cedar and maple along shore, Au Train Lake, Au Train, 2073, 2361

## LECANORACEAE

- LECANORA CINEREA* (L.) Röhling. — On rocks, Miner's Castle, Munising, 1712, 1720, on rocks along shore and in burn, Laughing Whitefish Point, Deerton, 1906, 1980, 2503; on rocks, near Bald Mountain, Big Bay, 2124, 2171, 2181; on rocks in gully, Sugarloaf Mountain, Marquette, 2298, 2312, 2317
- LECANORA LAEVATA* (Ach.) Nyl — On rocks of sheltered cliff facing the lake, Sugarloaf Mountain, Marquette, 2285

- LECANORA SUBFUSCA** (L.) Ach — On balsam along shore, Au Train Lake, Au Train, 2088
- LECANORA SUBFUSCA** var **ALLOPHANA** Ach — On hemlock branches in woods, Chatham, 1614, on dead birch in swamp, Rock River, 1805, on bark of white pine, near Bald Mountain, Big Bay, 2106
- LECANORA SUBFUSCA** var **ARGENTATA** Ach — On dead maple, Au Train, 1556, 1570, on beech and ash in woods, Chatham, 1619, 1623, 1634, on hemlock in woods and aspen on sand ridge and in burn, Rock River, 1791, 1834, 2212, on balsam in woods, Au Train Lake, Au Train, 2082, on aspen near the lake, Sugarloaf Mountain, Marquette, 2270
- \***LECANORA SUBFUSCA** var **CAMPESTRIS** Rabenh — On rocks along shore, Laughing Whitefish Point, Deerton, 1994, 1996, 2020, on rocks, near Bald Mountain, Big Bay, 2174, on rocks facing the lake, Sugarloaf Mountain, Marquette, 2250
- LECANORA SUBFUSCA** var **CHLARONA** Ach — On tree in woods, Wagner's Falls, Munising, 2044
- LECANORA HAGENI** Ach — On stump on point and on twigs along shore, Laughing Whitefish Point, Deerton, 1877, 1917
- LECANORA PALLIDA** (Schreb.) Rabenh — On maple in woods, Rock River, 1777, on trees along shore, Au Train Lake, Au Train, 2101
- LECANORA PALLIDA** var **CANCRIFORMIS** (Hoffm.) Tuck — On maple in swamp, Laughing Whitefish Point, Deerton, 2522
- LECANORA VARIA** (Hoffm.) Ach — On rocks along shore, near Rock River, 2392, on rocks along shore, Laughing Whitefish Point, Deerton, 2421, 2423
- LECANORA POLYTROPA** (Ehrh.) Rabenh — On rocks along shore, Sugarloaf Mountain, Marquette, 2329
- LECANORA FRUSTULOSA** (Dicks.) Ach — On rocks along shore, Laughing Whitefish Point, Deerton, 1905, 2491, on rocks, near Bald Mountain, Big Bay, 2140, 2157, 2167, 2170
- LECANORA SORDIDA** (Pers.) T. Fries — On rocks in gully and along shore, Sugarloaf Mountain, Marquette, 2243, 2303, 2321
- LECANORA MURALIS** var **SAXICOLA** (Poll.) Tuck — On rocks along shore, Laughing Whitefish Point, Deerton, 2009, 2454.
- LECANORA VERSICOLOR** (Pers.) Ach — On rocks along shore, Laughing Whitefish Point, Deerton, 1940, 2448, 2449
- LECANORA RUBINA** (Vill.) Ach — On exposed rocks, Miner's Falls,

- Munising, 1725, on rocks in gully and along shore, Sugarloaf Mountain, Marquette, 2302, 2330 (Smith)
- OCHROLECHIA TARTAREA* (L) Mass — On maple in woods, Onota, 1870, on trees, Au Train Lake, Au Train, 2196
- OCHROLECHIA PALLESCENS* (L) Mass — On ash in woods, Chatham, 1627, on cedar along shore, Au Train Lake, Au Train, 2057, 2094
- ICMADOPHILA ERICETORUM* (L) Zahlbr — On soil over rocks along lake shore, Miner's Castle, Munising, 1730, on old stumps in woods, Rock River, 1773, on old log in swamp, Laughing Whitefish Point, Deerton, 2528
- LECANIA ERYSIPE* (Ach) Mudd — On rocks, Laughing Whitefish Point, Deerton, 1889
- \**HAEMATOMMA ELATINUM* var *OCHROPHAEUM* (Tuck) Merrill & Burnh — On cedar along shore, Au Train Lake, Au Train, 2347, on cedar in swamp, Laughing Whitefish Point, Deerton, 2513
- HAEMATOMMA CISMONICUM* Belts — On pine in woods, Laughing Whitefish Point, Deerton, 2518
- CANDELARIELLA VITELLINA* (Ehrh) Müll Arg — On rocks along shore, Laughing Whitefish Point, Deerton, 1912, 2496, on rocks along shore, Sugarloaf Mountain, Marquette, 2334
- CANDELARIELLA AURELLA* (Hoffm) Zahlbr — On rocks along shore, Laughing Whitefish Point, Deerton, 1988, 2460, on rocks along shore, Sugarloaf Mountain, Marquette, 2323

#### PARMELIACEAE

- CANDELARIA CONCOLOR* var *EFFUSA* (Tuck) Merrill & Burnh — On old tree along river, Rock River, 2233
- PARMELIOPSIS ALEURITES* (Ach) Nyl — On conifer stump, Lake Superior shore, west of Au Train, 1659; on old stub and logs along shore, Au Train Lake, Au Train, 2093, 2350, on white pine, near Bald Mountain, Big Bay, 2107
- PARMELIOPSIS AMBIGUA* (Wulf) Nyl — On conifer stump, Lake Superior shore, west of Au Train, 1660, on decorticate log on ground, Miner's Falls, Munising, 1701, on rocks along shore and in burn, Laughing Whitefish Point, Deerton, 1913, 2022; on trees in burn, Rock River, 2218
- PARMELIOPSIS DIFFUSA* (Weber) Riddle — On decorticate log in ground, Miner's Falls, Munising, 1700; on old wood in burn, Rock River, 2219

- PARMELIA RUDECTA* Ach — On down hemlock in woods, Chatham, 1613, on cedar in swamp, Rock River, 1831, on cedar along shore, Au Train Lake, Au Train, 2096
- PARMELIA BORRERI* Turn — On tree, Au Train Lake, Au Train, 1592
- PARMELIA PHYSODES* (L) Ach — On living maple, Au Train, 1557, on conifer stump, Lake Superior shore, west of Au Train, 1658, on branches on ground, Wagner's Falls, Munising, 1765
- PARMELIA PERTUSA* (Schränk) Schaer — On trees along shore, Au Train Lake, Au Train, 2091, 2092, 2398
- PARMELIA PERLATA* (L) Ach — On log, Au Train Falls, Au Train, 1595, on tree, Miner's Falls, Munising, 1698, on cedar along shore, Au Train Lake, Au Train, 2095, 2363, on trees on cliff toward the lake, Sugarloaf Mountain, Marquette, 2283
- PARMELIA PERLATA* var *CILIATA* (Lam & DC) Duby — On cedar along shore, Au Train Lake, Au Train, 2060, 2079, 2080, 2363a, 2364
- PARMELIA CETRATA* Ach — On cedar along shore, Au Train Lake, Au Train, 2062
- PARMELIA SAXATILIS* (L) Ach — On trees, Miner's Falls, Munising, 1699, on rocks in burn, Laughing Whitefish Point, Deerton, 1982, 1993
- PARMELIA SULCATA* Tayl — On aspen in burn, Rock River, 1841
- PARMELIA TILIACEA* (Hoffm) Ach — On alders in swamp and maple in woods, Au Train, 1551, 1563
- PARMELIA CENTRIFUGA* (L) Ach — On rocks facing the lake, Sugarloaf Mountain, Marquette, 2241
- PARMELIA CAPERATA* (L) Ach — On down hemlock in woods, Chatham, 1612; on moss over rocks along shore, Rock River, 2385
- PARMELIA CONSPERSA* (Ehrh) Ach — On rocks along shore, Laughing Whitefish Point, Deerton, 1992a
- PARMELIA ASPIDOTA* (Ach) Röhl. — On beech in woods, Chatham, 1611, on trees and twigs in bog, Rock River, 1814, 1817
- PARMELIA SOREDIATA* (Ach) Röhl. — On exposed rocks, Miner's Castle, Munising, 1729, on rocks in burn and along shore, Laughing Whitefish Point, Deerton, 1979, 1983, 2007, on rocks, near Bald Mountain, Big Bay, 2177, on rocks in gully, Sugarloaf Mountain, Marquette, 2311
- PARMELIA OLIVACEA* (L) Ach — On aspen in burn, Rock River, 2213.



- CETRARIA OAKESIANA* Tuck — On bark of tree, Au Train, 1571; on logs and branches of trees in woods, Rock River, 1774
- CETRARIA JUNIPERINA* var *PINASTRI* (Scop) Ach — On maple in woods, Miner's Falls, Munising, 1707, on white pine along shore, Sugarloaf Mountain, Marquette, 2340 (Smith).
- CETRARIA LACUNOSA* Ach — On cedar along shore, Au Train Lake, Au Train, 2063, on tree in burn, Laughing Whitefish Point, Deerton, 2566
- CETRARIA AURESCENS* Tuck — On trees along shore, Au Train Lake, Au Train, 2064, 2353
- CETRARIA SAEPINCOLA* (Ehrh) Ach — On twigs and stems, Lake Superior shore, west of Au Train, 1645, on twigs in bog and swamp, Rock River, 1816; 2511 (Smith)
- CETRARIA CILIARIS* Ach — On larch in swamp, Rock River, 1802, on cedar along shore, Au Train Lake, Au Train, 2097
- CETRARIA ISLANDICA* (L) Ach — On soil over rocks along shore, Laughing Whitefish Point, Deerton, 1990, on soil in burn, Rock River, 2208

## USNEACEAE

- EVERNIA PRUNASTRI* (L) Ach — On conifer stump, Lake Superior shore, west of Au Train, 1661
- ALECTORIA JUBATA* (L) Ach — On exposed rocks, Miner's Castle, Munising, 1731, on spruce twigs in bog, Rock River, 1822, on dead spruce in swamp, Laughing Whitefish Point, Deerton, 2514.
- ALECTORIA JUBATA* var *IMPLEXA* (Hoffm) Ach — On dead spruce in swamp, Laughing Whitefish Point, Deerton, 2516
- ALECTORIA CHALYBEIFORMIS* (L) Röhlng — On dead spruce in swamp, Laughing Whitefish Point, Deerton, 2515
- RAMALINA CALICARIS* (L) Röhlng — On trees, Rock River, 1837, 1840, 2390, on white pine along shore, Laughing Whitefish Point, Deerton, 1922, on trees along shore, Au Train Lake, Au Train, 2102
- RAMALINA POLLINARIA* (Westr) Ach — Under rocks in burn, Laughing Whitefish Point, Deerton, 2499
- RAMALINA FARINACEA* (L) Ach — On hemlock log, Au Train Falls, Au Train, 1591, on exposed rocks, Miner's Castle, Munising, 1734, on rocks along shore, Laughing Whitefish Point, Deerton, 2010; on trees along shore, Au Train Lake, Au Train, 2078, 2352, on rocks along shore, Rock River, 2382.

- USNEA FLORIDA* (L) Web — On sticks on ground, Miner's Falls, Munising, 1706a, on spruce twigs in bog, Rock River, 1821
- USNEA HIRTA* (L.) Wigg. — On sticks on ground, Miner's Falls, Munising, 1706, on spruce twigs in bog, Rock River, 1823, on trees along shore, Au Train Lake, Au Train, 2100, 2195, on dead balsam, Laughing Whitefish Point, Deerton, 2415a
- USNEA CERATINA* (Ach) Schaer — On dead spruce in swamp, Laughing Whitefish Point, Deerton, 2523
- USNEA DASYPOGA* (Ach) Röhlhng — On alder and pine in swamp, Laughing Whitefish Point, Deerton, 2402, 2519, 2550
- USNEA DASYPOGA* var *PLICATA* (L) Cromb — On spruce along shore, Au Train Lake, Au Train, 2072
- USNEA CAVERNOSA* Tuck — On spruce twigs in bog, Rock River, 1818, 1819, 1820; on trees along shore, Au Train Lake, Au Train, 2099, on trees in swamp and along shore, Laughing Whitefish Point, Deerton, 2400, 2401, 2403, 2414, 2415, 2551, 2552

## CALOPLACACEAE

- CALOPLACA CINNABARINA* (Ach) Zahlbr — On rocks along shore, Laughing Whitefish Point, Deerton, 2459, 2460a
- \**CALOPLACA AURANTIACA* (Lightf) T Fries — On aspen on sand ridge, Rock River, 1833, on rocks in gully, Sugarloaf Mountain, Marquette, 2244, 2289, 2305, on aspen along shore and on rocks along shore and in burn, Laughing Whitefish Point, Deerton, 2453, 2476, 2498
- CALOPLACA CERINA* (Ehrh) T Fries — On aspen, Au Train Falls, Au Train, 1598.
- CALOPLACA SIDERITIS* (Tuck) Zahlbr — On rocks along shore, Laughing Whitefish Point, Deerton, 2492.
- CALOPLACA MURORUM* (Hoffm) T Fries — On rocks along shore, Sugarloaf Mountain, Marquette, 2322, 2327, 2336
- CALOPLACA ELEGANS* (Link) T Fries — On rocks along shore, Laughing Whitefish Point, Deerton, 1987, 1989 . .

## TELOSCHISTACEAE

- TELOSCHISTES LYCHNEUS* (Ach) Tuck. — On beech, Miner's Falls, Munising, 1663
- TELOSCHISTES POLYCARPUS* (Ehrh.) Tuck. — On aspen, Au Train Falls, Au Train, 1597.

## BUELLIACEAE

- BUELLIA PUNCTATA** var **POLYSPORA** (Willey) Fink — On aspen in burn, Rock River, 2216
- RINODINA OREINA** (Ach) Mass — On exposed rocks, Miner's Castle, Munising, 1717, on rocks, near Bald Mountain, Big Bay, 2161, 2191

## PHYSICIACEAE

- PYXINE SOREDIATA** (Ach) E Fries — On cedar along shore, Au Train Lake, Au Train, 2059, 2357, 2360a
- PHYSICIA TERETIUSCULA** (Ach) Lynge — On rocks along shore, Laughing Whitefish Point, Deerton, 1914, 2024, 2031, 2470, on rocks, near Bald Mountain, Big Bay, 2127
- PHYSICIA CAESIA** (Hoffm) Hampe — On beech, Au Train, 1564
- PHYSICIA VIRELLA** (Ach) Flagey — On aspen log, Au Train Falls, Au Train, 1599a, on maple along road, Onota, 1861, on cedar along shore, Au Train Lake, Au Train, 2058a
- PHYSICIA OBSCURA** (Ehrh) Hampe — On aspen log, Au Train Falls, Au Train, 1599, on aspen on sand ridge and in burn, Rock River, 1839, 2214a, 2215
- PHYSICIA ENDOCHRYSEA** (Hampe) Nyl — On beech in woods, Miner's Falls, Munising, 1664
- PHYSICIA STELLARIS** (L) Nyl — On aspen log, Au Train Falls, Au Train, 1600, on beech in woods, Chatham, 1618, on aspen in burn, Rock River, 2214
- PHYSICIA PULVERULENTA** (Schreb) Nyl — On log along trail in woods, Miner's Falls, Munising, 1670; on cedar along shore, Au Train Lake, Au Train, 2354.
- PHYSICIA PULVERULENTA** var **LEUCOLEIPTES** Tuck — On maple log and ash tree in woods, Chatham, 1607, 1630
- PHYSICIA HISPIDA** (Schreb) Frege — On white pine along shore, Laughing Whitefish Point, Deerton, 1923
- PHYSICIA LITHOTEA** (Ach) Nyl. — On rocks along shore, Laughing Whitefish Point, Deerton, 1907.
- ANAPTICHA SPECIOSA** (Wulf) Mass — On ash in woods, Chatham, 1631, on twigs in bog, Rock River, 1873
- ANAPTICHA HYPOLEUCA** (Mühlb) Mass — On cedar along shore, Au Train Lake, Au Train, 2058, 2061, 2360.

*ANAPTYCHIA AQUILA* (Ach) Mass — On cedar along shore, Au Train Lake, Au Train, 2058b

*ANAPTYCHIA LEUCOMELAENA* (HBK) Vainio — On down cedar along shore, Au Train Lake, Au Train, 2356

LEPRARIACEAE

*AMPHILOMA LANUGINOSUM* (Hoffm) Nyl — On stump in woods, Laughing Whitefish Point, Deerton, 2548

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## NOTES ON PLANT ECOLOGY OF NORTHERN ONTARIO

LESLIE A. KENOYER

**I**N AUGUST, 1932, the writer, with a class of eight students, made a botanical tour in northern Ontario, as far northward as the southern tip of James Bay, for the purpose of studying problems of plant distribution. The area investigated has been made accessible by the opening of an automobile highway to Cochrane and the extension of the Temiskaming and Northern Ontario Railway from Cochrane to Moosonee. We traveled by motor cars to Cochrane, thence by train to Moosonee, which is about one hundred and fifty miles north of Cochrane, and from there by motor boat twelve miles farther, to Ship Sands Island, where the Moose River enters James Bay.

The principal studies were made (1) at Gravenhurst, on Lake Muskoka, in the deciduous forest zone; (2) at Martin River Camp, in the Timagami Forest Reserve, a pine-dominated area of the coniferous forest region, and (3) at Cochrane, in a spruce- and fir-dominated northerly area of the coniferous forest region. Approximately four days were spent at each of these localities. Shorter stops were made at New Liskeard, north of Martin River, on Lake Temiskaming; at Swastika, still farther north, an important gold-mining center on the continental divide between the Great Lakes and Hudson Bay; and at Moosonee, near James Bay, in a region dominated by subarctic forest and muskeg.

### I PLANT FORMATIONS

#### *Maple-Beech-Hemlock Forest at Lake Muskoka*

The region about Lake Muskoka, although largely cut over by the lumbermen, contains areas of good maple-beech-hemlock climax forest. A sample count of large trees in a transect of a typical area gave sugar maple 9, beech 3, hemlock 3. The underlying rock is

pre-Cambrian gneiss, crumpled and coarsely banded, with pegmatite or granitic intrusions in the dikes. The hills are of the type known as *roches moutonnées*, carved by glacial erosion from the original rock mass. The uniform level of the higher ones indicates that previous to erosion the region was almost a plain. This contour, numerous rock striations, and the frequent occurrence of sheets of till point to thorough glaciation of the region. In the troughs between hills are many lakes and marshes. Since much of the country has not reached a stage of physiographic development capable of supporting climax forest, conifers and other rock-surface pioneers are abundant. A transect of one of the rocky pioneer areas gives white pine 9, white birch 8, quaking aspen 8, red oak 4. Large-toothed aspen, white oak, red maple, and arbor vitae occur to some extent, the last usually near the lake borders.

The stages in the xerarch succession from rock to forest were found to be as follows.

- 1 Lichens — Crustose, foliose, and fruticose types
- 2 Mosses — Notably *Ceratodon purpureum*, occurring as cushions on the rocks, followed by *Polytrichum piliferum*, which appears in the center of each cushion as it enlarges
- 3 Ferns and other herbs of rock or crevice — *Polypodium vulgare*, *Aspidium marginale*, *Woodsia ilvensis*, *Saxifraga virginicensis*, *Selaginella rupestris*, *Moss-anthemum canadense*
- 4 Low shrubs — *Arctostaphylos Uva-ursi*, *Vaccinium pennsylvanicum*, *Juniperus communis*
- 5 Larger shrub — *Rhus typhina*
- 6 Pioneer trees — *Pinus Strobus*, *Quercus alba*, *Quercus rubra*, *Thuja occidentalis*, *Betula alba papyrifera*
- 7 Climax trees — *Acer saccharum*, *Fagus grandifolia*, *Tsuga canadensis*

## 2 White Pine Forest in Timagami Forest Reserve

In the Timagami Forest Reserve much of the timber along the highway has been cut, but there are still considerable tracts of virgin forest. A transect in one of these gave white pine 16, balsam fir 6, white birch 6. There is but little yellow birch, for this species here reaches its northerly limit. Red pine is conspicuous in places, particularly on the rocky uplands. The climax trees of the Muskoka region are almost absent here, since there is neither beech nor hemlock and but very little sugar maple occurs. The dominant rôle is assumed

by white pine, not by spruce and fir, as in the areas farther north. This pine appears at an early stage in succession and persists to the climax stage. White birches are everywhere obvious, but especially so in the localities from which the pines have been removed by lumbermen. In this region are many bogs, in which black spruce and tamarack are dominant trees. Some of these bogs are on hilltops and slopes. All are carpeted with picturesque *Cladoniae* and lichens.

### 3 *Transitional Zone*

At New Laskeard, on the northern end of Lake Temiskaming, the forest is similar to that of the Timagami region. Innumerable seedlings of elm and red maple, growing on the sand of the lake beach, show that a deciduous forest element is present even so far north. Above New Laskeard lies a broad strip of glacial debris, the southern clay belt, which is being developed agriculturally and contains but little undisturbed forest. At Swastika a pre-Cambrian dome separates the southern from the northern clay belt. This point is about the northernmost limit of the white pines, and a transition to the more northerly fir-spruce forest type is apparent. One striking feature is a stretch of several miles of sandy glacial outwash with an almost pure stand of jack pine. These are large trees, sixty feet tall, a height rather unusual for this species. A transect here taken gives jack pine 23, white birch 3, white pine 2, black spruce 1. The young trees are mainly white birch and black spruce. It is probable that the jack-pine forest represents a subclimax, which would be succeeded in time by white birch, fir, and, possibly, white spruce. The outwash sand and silt are here deposited in annual layers or varves.

### 4 *Fir-Spruce Forest at Cochrane*

In the midst of the northern clay belt lies Cochrane, the most northerly city on the improved highway. The surrounding area is a flat glacial moraine on which agricultural developments are beginning. The soil is immature, the greater part of the area being muskeg, a mossy turf covered with bog shrubs, and with black spruce and tamarack in the proportion of about three to one. In places with better drainage young balsam fir is mixed with the older bog trees. In relatively few areas, in the best-drained soil, the vegetation has apparently reached a climax of fir and white spruce, with a fair sprinkling of the deciduous trees — balsam poplar, quaking aspen,



and white birch. Transects taken in this climax forest gave fir 20, black spruce 12, balsam poplar 12, quaking aspen 10, white spruce 9, white birch 6. The black spruce is doubtless a holdover from the bog stage, indicating that the climax has not been fully attained. Along the Abitibi River is considerable arbor vitae, evidently, as is usual for this species, playing the rôle of a pioneer. There is some question whether the deciduous trees mentioned above really belong to the climax stage, although it seems probable that this distinction should be accorded to balsam poplar and white birch at least. The relatively short time that has elapsed since the glacial period and the slowness of soil maturation in this cool climate may, as suggested by Hutchinson,<sup>1</sup> account for the fact that so small a percentage of the land area has reached the climax stage of development.

#### 5. Muskeg at Moosonee

The country at the lower end of James Bay is described on the official vegetation map as relatively treeless muskeg. The railway to Moosonee follows the Abitibi River to its mouth and then runs along the Moose River. So far as could be determined in the full moonlight of the frosty August nights of our journey, spruce is the dominant tree. But as one proceeds northward the spruces gradually become smaller until, in the boundless expanse of muskeg that surrounds the railway station at Moosonee, the mossy turf is sparsely covered with spindly lichen-bedecked black spruce and tamarack not more than ten to fifteen feet in height. In the better-drained areas near the mouth of the Moose River there are many balsam poplars and some firs. This is probably a nearer approach to the climax than is the poorly drained muskeg occupying most of the level area of the James Bay basin. The undershrubs of this river-bank forest are largely species of willow. In newly formed and relatively moist flood plain areas, such as those we explored at Ship Sands Island, where the river enters James Bay, these willows are the most important element in the vegetation. Included among them here are *Salix lucida*, *S. sylvicola*, *S. discolor*, and *S. serotina*. Probably over the flat muskeg the fir and balsam poplar would eventually follow black spruce and tamarack, although in this inst-

<sup>1</sup> Hutchinson, A. H., "Limiting Factors in Relation to Specific Ranges of Tolerance of Forest Trees," *Bot. Gaz.*, 66: 465-493. 1918.

tude, where the subsoil in places does not thaw out completely during the entire summer, any successional change would be very slow

The number of species of vascular plants tends to decrease with an increase in the degree of latitude, as may be indicated by the fact that approximately equal periods spent in collecting at the three important points resulted in the listing of the following numbers: Muskoka Lake, 205; Martin River, 179, Cochrane, 140

## II FREQUENCY STUDIES OF FOREST-FLOOR SPECIES

In order to compare the frequency of the smaller shrubs and herbs we used the method of survey suggested by Raunkiaer<sup>1</sup> By means of a wire measured to the right length to serve as the radius of a circle of the desired size twenty-five sample plots were circumscribed in each association selected for study, and the species occurring on each plot listed The plots in a given association were spaced an equal number of steps apart The area of 0.1 square meter, found most suitable by Raunkiaer in his investigations in Europe, is the one usually employed, but in two areas where the forest-floor vegetation was sparse plots of one square meter were used instead These surveys were made in nineteen typical plant associations selected in the region from Lake Muskoka to Cochrane

The species found on the sample plots of each association studied were grouped in the order of their frequency. Thus a species occurring on all twenty-five of the plots is rated as 100 per cent frequent, one found on only twenty as 80 per cent frequent, etc On the average, the species showing a frequency of up to 20 per cent comprise 63 per cent of the entire number listed Those with a frequency of 20 to 40 per cent follow, with 17 per cent of the number; the 40 to 60 per cent group provide 10 per cent; the 60 to 80 per cent group, 6 per cent; the 80 to 100 per cent group, 4 per cent These percentages — 63, 17, 10, 6, and 4 — form an approximately hyperbolic curve, and thus conform to the usual pattern of species distribution.

This survey gives data for comparison of the different forest-floor plants of the Ontario flora In Table I are found in the order of their frequency the ten most abundant species in the nineteen areas surveyed.

<sup>1</sup> Raunkiaer, Christen, "Recherches statistiques sur les formations végétales." *Kl. danske vidensk. Selsk., Biologiske Meddel.*, 1:3. København, 1918.

TABLE I  
PLANTS MOST FREQUENT IN NINETEEN AREAS

	<i>Average frequency for the 19 areas</i>	<i>Number of areas on which species occur</i>
<i>Maianthemum canadense</i>	42	18
<i>Cornus canadensis</i>	34	18
<i>Vaccinium pennsylvanicum</i>	28	12
<i>Aster macrophyllus</i>	21	12
<i>Aralia nudicaulis</i>	19	13
<i>Mitella nuda</i>	18	7
<i>Clintonia borealis</i>	17	11
<i>Linnaea borealis americana</i>	15	12
<i>Rubus triflorus</i>	15	8
<i>Coptis trifolia</i>	13	9

The species showing the ten highest frequencies in each of the three general association types are given in Tables II, III, and IV:

TABLE II  
PLANTS MOST FREQUENT IN NINE CLIMAX-ASSOCIATION AREAS  
(With average frequencies)

<i>Maianthemum canadense</i>	47
<i>Cornus canadensis</i>	37
<i>Mitella nuda</i>	30
<i>Aster macrophyllus</i>	29
<i>Aralia nudicaulis</i>	27
<i>Clintonia borealis</i>	25
<i>Rubus triflorus</i>	22
<i>Vaccinium pennsylvanicum</i>	20
<i>Coptis trifolia</i>	16
<i>Vaccinium canadense</i>	13

TABLE III  
PLANTS MOST FREQUENT IN FIVE XERARCH SUBCLIMAXES  
(With average frequencies)

<i>Vaccinium pennsylvanicum</i>	60
<i>Maianthemum canadense</i>	45
<i>Cornus canadensis</i>	32
<i>Gaultheria procumbens</i>	20
<i>Linnaea borealis americana</i>	18
<i>Pteris aquilina</i>	18
<i>Aralia nudicaulis</i>	15
<i>Aster macrophyllus</i>	15
<i>Trientalis americana</i>	14
<i>Vaccinium canadense</i>	13

TABLE IV

PLANTS MOST FREQUENT IN FIVE HYDRARCH SUBCLIMAXES  
(With average frequencies)

<i>Chamaedaphne calyculata</i>	36
<i>Carex oligosperma</i>	34
<i>Maianthemum canadense</i>	31
<i>Cornus canadensis</i>	30
<i>Vaccinium oxycoccus</i>	23
<i>Kalmia polifolia</i>	20
<i>Ledum groenlandicum</i>	20
<i>Coptis trifolia</i>	16
<i>Andromeda glaucophylla</i>	16
<i>Mitella nuda</i>	15

From these tables it is apparent that *Maianthemum canadense* and *Cornus canadensis* are the two most frequent plants in the sections of Ontario studied. Since they are among the ten leaders in each of the three association types they grow under a wide range of conditions.

It will be observed that some of the hydrarch dominants decrease early, dropping below tenth place in the climax associations. In many parts of the climax forest some of these, notably *Chamaedaphne*, *Ledum*, and *Kalmia*, may be found, but are infrequent. Others, such as *Cornus*, *Maianthemum*, and *Mitella*, come early and persist until late in successional development. *Aster* and *Aralia* appear rather late. As with the hydrarchs, several of the xerarch dominants also drop out or become relatively infrequent before the mesic stage is reached.

Lines between the pioneer and the climax stages are much less sharply drawn than in the more southerly temperate regions. In southern Michigan, for instance, it is probable that none of the ten most frequent species of either the bog or the sand barren would be included among the ten most frequent in the climax forest, whereas in the Ontario study it will be noted that two of the foremost ten of the climax (Table II) are frequent in both xerarch (Table III) and hydrarch (Table IV) pioneer associations, and that five others of the former list are found in one or the other of the last two. In southern Michigan seven or eight of the ten frequent in the Ontario climax forests are virtually restricted to cold bogs. It is evident either that the northern climate has a leveling influence on vegetation or that, as suggested by Hutchinson (*op. cit.*), the soil of the north, owing

to slow decomposition and other chemical change at low temperatures, has not had time to mature sufficiently to enable it to maintain a climax vegetation

A rough check on the influence of latitude on species distribution is given in Table V, in which the frequencies of several species in eight areas south of the continental divide between the Great Lakes and Hudson Bay are compared with the frequencies of the same species in nine areas north of the divide

TABLE V

## SPECIES FREQUENCY IN RELATION TO LATITUDE

	Percentage frequency	
	South of divide	North of divide
<i>More frequent southward</i>		
<i>Aster macrophyllus</i>	26	10
<i>Aralia nudicaulis</i>	26	10
<i>Clintonia borealis</i>	23	10
<i>Pteris aquilina</i>	15	0
<i>Gaultheria procumbens</i>	14	0
<i>More frequent northward</i>		
<i>Mitella nuda</i>	45	34
<i>Rubus triflorus</i>	45	27
<i>Linnæa borealis americana</i>	10	21

The students who gathered the data for this paper are Helen Maul, Jean McClave, Hazel Smith, George Hoehne, and Loretta Locher.

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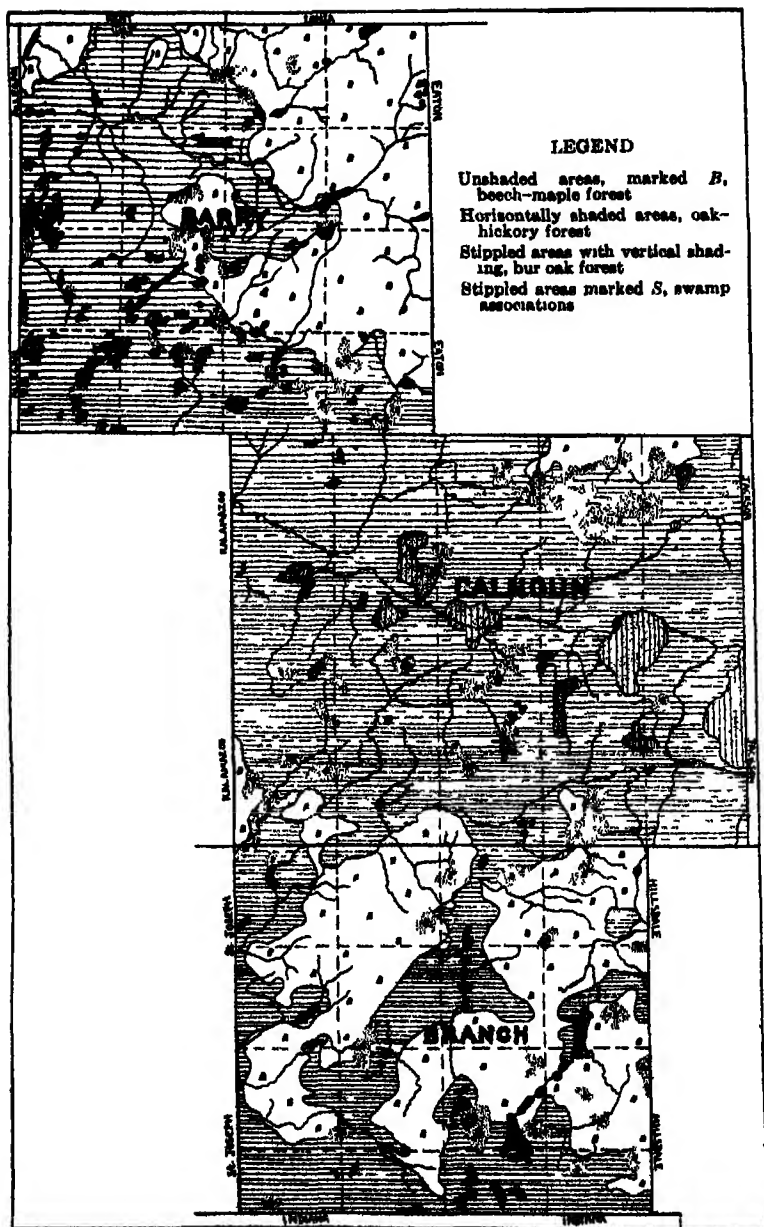
# PLANT ASSOCIATIONS IN BARRY, CALHOUN, AND BRANCH COUNTIES, MICHIGAN, AS INTERPRETED FROM THE ORIGINAL SURVEY

LESLIE A. KENOYER

**T**HE purpose of this paper is to extend the analyses, already published (2, 3), in which six counties in the southwestern corner of Michigan (Berrien, Van Buren, Allegan, Cass, St Joseph, and Kalamazoo) were mapped to show the plant associations existing at the time of the government land survey, 1826 to 1832, and interpreted from the recorded witness trees. This addition embraces Barry, Calhoun, and Branch counties (Fig 1), which adjoin on the east those previously studied.

Two witness trees near each section corner and two near the midpoint of each section are named by species. Since trees of ecologically associated species formed well-defined groups when recorded on the county map, it is possible to set fairly definite boundary lines to the areas occupied by the various plant associations. These three counties agree with those already mapped in that oak-hickory and beech-maple forest were the prevailing associations. They were entirely devoid of hemlock, and, except for an occasional white pine, were without pine forest. This confirms the earlier conclusion that hemlock and pine in southeastern Michigan were practically restricted, as they are at present, to the vicinity of Lake Michigan. The area included in the present paper had no well-defined grassland tracts, such as were found in St. Joseph, Kalamazoo, Cass, and Berrien counties. There were, however, in Calhoun County eight small areas in which bur oak was almost the only tree. Since bur oak invariably occurred to some extent in the grassland tracts just mentioned, it is probable that there was a grassy undercover in these small patches in Calhoun County.

Although the greater part of the boulder clay plains area indicated



**Fig 1 Plant associations of Barry, Calhoun, and Branch counties**

for these counties on Leverett's map (4) was occupied by beech-maple forest, the correlation between beech-maple and boulder clay was at best rather vague. In Barry County, where most of the beech-maple was in a single block, its extent corresponds in a general way with Miami loam on the soil map (1). This finding agrees with that of Veatch (5) from a sample survey comprising portions of five counties of southern Michigan.

It will be observed that Barry County is divided by a roughly diagonal line into a southwestern oak-hickory portion and a northeastern beech-maple portion. The former, as compared with the latter, is poorly drained, with many lakes and few streams. On the other hand, Calhoun County, with three large rivers and few lakes, was almost entirely oak-hickory forest, whereas Branch County, with fewer streams and more lakes than Calhoun, was more than half beech-maple forest. The mapping of other Michigan areas will doubtless throw more light on the factors behind distribution.

Acknowledgment is given the registers of deeds of the three counties for permission to use the field books.

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## CORDYCEPS SPECIES FROM MICHIGAN \*

EDWIN B MAINS

NINE species of Cordyceps have been reported for Michigan. *C. clavulata* Schw. (9, 10, 18), *C. formicivora* Schroet. (17), *C. gracilis* (4 as *C. entomorrhiza*, 10), *C. Melolanthae* (Tul) Sacc (6 as *C. herculea*, 11), *C. michiganensis* Mains (10), *C. militaris* Link (10, 16, 17, 18), *C. ophioglossoides* Link (10), *C. stylophora* Berk & Br. (2, 9), and *C. superficialis* (Peck) Sacc. (5). In this paper additional information and records of distribution are given for a number of them. Three species are added, one new, bringing the total for the state to twelve. In 1910 Seaver (20) reported thirteen species for the United States. Several of these have since been shown to be synonymous, and some new ones have been described. The number now recorded for the United States is twenty-one.

### *Cordyceps ophioglossoides* Link

On *Elaphomyces* sp., Kent Lake, Oakland Co., Aug. 26, 1937, A. H. Smith.

This is a fairly common species in Michigan. It has club-shaped clavae, short-cylindric part spores, and is attached to the subterranean tubers of *Elaphomyces* by rhizomorphs. In these characters it differs from the following species.

### *Cordyceps capitata* (Holmsk.) Link

On *Elaphomyces* sp., Kent Lake, Oakland Co., Sept. 19, 1937, A. H. Smith (7610).

This is apparently the first report of the species from Michigan. It doubtless is of more frequent occurrence than the one record would indicate. The clavae are capitate and are seated directly on the tubers; the part spores are slightly fusoid, 34-50  $\mu$  long and 4  $\mu$  wide.

\* Papers from the Department of Botany and the Herbarium of the University of Michigan.

*Cordyceps stylophora* Berk. & Br.

On larvae of beetles, A H Smith, Oakland Co Kent Lake, Aug 26, 1937, and Sept 13, 1937 (7311, 7554), Horseshoe Lake, Sept 24, 1937 (7733), Milford, Oct 24, 1938 (11120)

This is a very interesting species. It has been rarely collected. It was first reported (2) for Michigan from a collection made by G H Hicks in 1892 near East Lansing The type was obtained (1) by Ravenel in South Carolina about 1857 A H Smith recently found it in New York and in the Great Smoky Mountains National Park

The collections listed above are immature, having either undifferentiated asci or asci without differentiated ascospores This is puzzling because A H Smith first observed the clavate of collection 11120 on July 10 and did not collect them until October 24, when spores had not formed The persistence of the clavate for so long a period is unusual in *Cordyceps* Ample opportunity should have been afforded for maturation

*Cordyceps unilateralis* (Tul.) Sacc.

Povah (17) reported a specimen of *Cordyceps* on an ant from Rock River, Alger Co., as *C. formicivora* Schroeter (Pl I, Fig 2) Apparently Schroeter's original record (19) of the species from Germany is the only other published report of its occurrence Petch (15) has recently decided that *C. formicivora* is only a variation of *C. unilateralis* The clavate of *C. formicivora* were described as capitate, with the perithecia in the terminal heads *C. unilateralis* has the perithecia in pulvinate stromata located laterally at various places on the clavate (Pl I, Figs 1-3) Petch reached his conclusion as a result of a study of collections from the Farlow Herbarium of Harvard University An examination of these collections has resulted in the same conclusions The stromata develop at various points on the clavate and occasionally terminally The species has clavate asci and fusoid ascospores, and Petch (12) has placed it in *Ophiocordyceps*

*Cordyceps Melolanthae* (Tul.) Sacc.

On "June beetle" larvae, Silver Lake, Washtenaw Co., Aug. 5, 1935, A H Smith (1718).

Two other collections have been reported (6, 11) from Wash-

tenaw County Specimens that appear to be of this species have also been received from S A Graham They were collected in the Huron National Forest at the Mack Lake Tower, near Mio, Oscoda County They are immature, and the clavæ are sterile The species has usually been reported as *C herculea*, a name which is not tenable (7, 10, 14)

*Cordyceps gracilis* Mont & Dur.

On larvae of beetles, Lakeland, Livingston Co, June 4, 1936, A H Smith (3966), Ann Arbor, Washtenaw Co, June 12, 1937, A H Smith (6375); Sharon Hollow, Washtenaw Co, June 26, 1937, A H Smith (6419)

Three other collections have been reported (4, 10) under this name from Wayne, Cheboygan, and Marquette counties Of these, two are on larvae of beetles and one is on a larva of a lepidopterous insect Only two other collections have been reported (8) from the United States, one from New York and the other from Indiana

The Michigan collections (Pl II, Figs 1-3) have capitate clavæ, which are 3-9 cm long The heads are cinnamon-buff to mahogany-red and are punctate from the ostioles They are globoid to ovoid,  $3-6 \times 2-4$  mm The stalks are buff, chrome-yellow, or orange-yellow and are 1-2 mm thick The perithecia are entirely embedded and are narrow-ovoid or fusoid-ovoid,  $720-840 \times 240-360 \mu$  The asci are cylindric,  $442-540 \times 4-5 \mu$  The ascospores are filiform and are nearly as long as the asci They break into part spores which are  $6-9 \times 1-1.5 \mu$  Only one of the Michigan specimens on beetle larvae develops from the middle of the larva The others arise from an end One specimen has a moderate amount of slender light-colored mycelial strands surrounding the lower part of the stalk The specimen from lepidopterous larva (Pl II, Fig 1) arises from one end and lacks mycelial strands It does not differ to any appreciable extent from the specimens on beetle larvae

There has been considerable uncertainty regarding the name which should be applied to this fungus Until fairly recently most of the specimens have been named *C entomorrhiza* (Dicks.) Link. In 1913 Lloyd (7) pointed out that *C. entomorrhiza* is the fungus which had been known on the continent of Europe as *C cinera* and that the species to which the name had generally been given is *C gracilis*. According to Lloyd and Petch, the collections of Ravenel, upon

which Ellis and Everhart's and Seaver's records (2, 20) of *C. entomorrhiza* are based, are *C. ophioglossoides* Lloyd reported in 1920 that he had seen only two collections of *C. gracilis* from the United States. In 1934 the writer listed three collections from Michigan.

Recently Petch (13) has questioned the occurrence of *C. gracilis* in America and has concluded that the fungus reported as such is *C. Glazovii* P. Henn. In his description of *C. Glazovii* Hennings (3) gives the following information: Clava capitate; the stalk pallid, 6 cm long, 2-3 mm. thick; the head rufous brown, ovoid-spheroid, 5-7 × 5 mm.; the perithecia immersed, subglobose, the asci cylindrical, 120-180 × 4-5  $\mu$ , the spores filiform, multiseptate, breaking into numerous segments 0.5  $\mu$  thick. The host is doubtfully determined as a larva of a butterfly. Petch (13) states that the host is a larva of a beetle. The Michigan collections show several important points of difference, having narrow-ovoid to fusoid-ovoid perithecia (Pl. II, Fig. 3) and long asci, 442-540  $\mu$ .

Petch (13) places considerable emphasis on the following characters, by which he would distinguish *C. gracilis*: presence of free, abundant mycelial strands at the bases of the clavæ; development of clavæ from the ends of the larvae, and the hosts, lepidopterous larvae. The Michigan fungus occurs on larvae of beetles as well as of lepidopterous insects. The clava usually develops from one end of the larva, but may arise elsewhere. Although free mycelial strands are ordinarily lacking, a moderate development sometimes occurs. These differences hardly justify, however, the exclusion of the Michigan collections from *C. gracilis*.

### ***Cordyceps macularis*, comb. nov.**

*Ophiocordyceps macularis* Mains, Proc. Am. Phil. Soc., 74: 269, 1934.

The species was described from a collection made at Harbor Springs, Emmet County. It has been collected in New York also (11). Petch established the genus *Ophiocordyceps* for the species of *Cordyceps* having clavate asci and fusoid ascospores which overlap in the asci. Species with these characters do not appear to form a natural group, but are more closely related to species of *Cordyceps* than to each other.

*Cordyceps michiganensis* Mains

On larvae of beetles, A H Smith: Bass Lake, Washtenaw Co., June 15, 1937 (6306); Milford, Oakland Co., July 29, 1937 (6684)

The species was described (10) in 1934 from collections from Alger and Livingston counties. It has also been collected (11) at Timagami, Ontario, and A H Smith recently obtained it in the Great Smoky Mountains National Park. It is a small species, with a number of slender orange clavæ growing from the larvae. It is easily overlooked, especially when it is associated with sporophytes of mosses.

*Cordyceps paludosa*, sp. nov.

*Clavis filiformibus*, 5.5–13 cm longis, 0.5–1.0 mm crassis, griseo-brunneis, terminantibus in acuminatis sterilibus apicibus, peritheciis superficialibus, liberis, lateraliter compressis, ovoideis,  $800\text{--}855 \times 375\text{--}410 \mu$ , asci cylindricis,  $480\text{--}550 \times 8\text{--}10 \mu$ ; ascosporis filiformibus,  $390\text{--}490 \times 2.0\text{--}2.5 \mu$ , multiseptatis, septis 12–18  $\mu$  distantibus (Tab III, Figg 1–2)

In larvis lepidopterarum, Kent Lake, Oakland County, A. H. Smith, Sept. 13, 1937 (7559, specimen typicum), July 28, 1938 (9640)

This species has long, slender filiform clavæ, 5.5–13 cm  $\times$  0.5–1.0 mm. They are grayish brown, especially in the lower part, and are covered with a matted felt. They terminate above in long, attenuated acuminate apices. The perithecia are flattened-ovoid and are large,  $800\text{--}855 \times 375\text{--}410 \mu$ . The lower portion is grayish brown and the upper is deep brown. They are superficial, free, and often crowded. The asci are cylindric,  $480\text{--}550 \times 8\text{--}10 \mu$ . The ascospores are filiform,  $390\text{--}490 \times 2.0\text{--}2.5 \mu$ , and are multiseptate, the cells being 12–18  $\mu$  long and not readily separating.

This species is related to *C. superficialis* and *C. acicularis*. The former is much smaller, having clavæ up to 4.5 cm long. The perithecia are  $360\text{--}660 \times 300\text{--}564 \mu$ , and the asci are  $150\text{--}270 \times 7\text{--}9 \mu$ . The ascospores break into segments  $14\text{--}30 \times 1.5\text{--}2 \mu$ . *C. superficialis* has been collected on larvae of beetles.

*C. acicularis* has clavæ up to 10 cm long and 1–2 mm. thick. The perithecia are  $360\text{--}400 \times 270\text{--}300 \mu$ ; the asci are clavate, 210–

$290 \times 7-10 \mu$  The ascospores are slightly fusoid,  $160-240 \times 2.5-4 \mu$  They are multiseptate and do not break into segments *C. acicularis* develops from larvae of beetles

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*Cordyceps unilateralis*

FIG 1 Typical form with pulvinate stromata laterally placed on clava (Farlow Herb No 4057)  $\times 5$

FIG 2 The form described as *C. formicivora*, with the stromata terminal (Michigan collection)  $\times 10$

FIG 3 An intermediate form (Farlow Herb No 4048)  $\times 10$



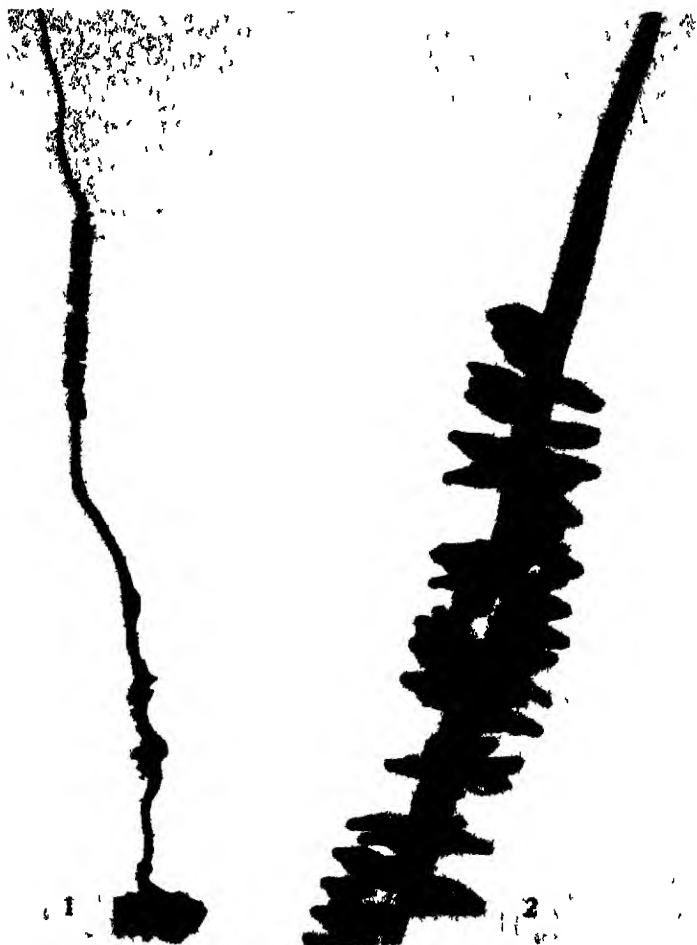




*Cordyceps gracilis*

- FIG 1 Capitula clava arising from a lepidopterous larva  $\times 15$   
 FIG 2 Head showing ostioles of the embedded perithecia  $\times 10$   
 FIG 3 Perithecia  $\times 70$





*Cordyceps paludosa*

FIG 1 Clava arising from a lepidopterous larva  $\times 1$

FIG 2 Portion of a clava showing the superficial free perithecia  $\times 10$



## NUCLEI IN ACTINOMYCES \*

EARL H. NEWCOMER AND GLENN KENKNIGHT

**T**HE genus *Actinomyces* includes filamentous organisms with a very fine branching mycelium, usually less than a micron in diameter and seldom exceeding 1.5 micra in diameter. Whether or not the mycelium is septate is a matter of considerable disagreement. Reproduction occurs by conidia or by fragmentation spores.

Some investigators classify the Actinomycetes as fungi, others as bacteria, and still others as a distinct group, separate from both fungi and bacteria. They resemble fungi in that they generally produce an abundance of mycelium with true branching, and some species bear aerial conidiophores with conidia in chains. They are of about the same size as bacteria and are like them in that they are usually intolerant of an acid medium. Furthermore, the majority of them take the Gram stain, certain ones are acid-fast, some prefer a reduced oxygen tension, and several species are reported to have been lysed by a bacteriophage (8).

Whether bacteria possess true nuclei is a question that has received considerable attention from many investigators. Although some have reported the presence of discrete nuclei, the nucleus if present is usually considered to be diffuse in nature and not limited by a definite membrane (3, 5). Fungi, on the other hand, possess true nuclei, and this nuclear condition is an important criterion of phylogenetic significance for the separation of fungi from bacteria.

Various workers using cytological stains have reported in the cytoplasm darkly staining bodies which were interpreted by some as nuclei, but by others as metachromatic bodies, ergastic in nature (1, 2, 4). Unfortunately, the lack of specificity of these cytological stains narrowly limits the value of any such observations to purely morphological interpretations.

The Feulgen reaction has long been known and accepted as a

\* Journal Article No. 357, N. S., of the Michigan State College Experiment Station

specific stain for chromatin, and recent improvements in its use as well as the standardization of its constituent basic fuchsin have placed in the hands of workers a highly valuable technique, which is now as reliable as it once was capricious. The authors have used this technique in the course of this study of the nuclear condition in several representatives of the genus *Actinomyces*.

The organisms were cultured on slides and stained *in situ* by a method devised by Newcomer (6). The medium employed consisted of 1 per cent glucose, 0.05 per cent peptone, 1.2 per cent agar, and 2 per cent gelatin in distilled water. The pH of the medium was adjusted to neutrality with NaOH.

The organisms, after periods of growth of from 3 to 21 days in moist chambers, were killed with Nawaschin's fluid and stained by means of the Feulgen technique, as modified by Tomasi (7). In early preparations much of the aerial mycelium was lost from the slides in the rather rigorous preliminary treatment requisite for the Feulgen reaction. This was subsequently avoided to a large extent by the simple expedient of placing the slides face down in the killing fluid. When several slides are piled one on top of the other, the gentle pressure thus exerted fixes the aerial mycelium firmly to the gelatin fixative. The technique is still susceptible to improvement, however, and further modifications are contemplated.

In the *Actinomyces* so prepared and examined discrete intramycelial inclusions of nuclear morphology, which gave a positive reaction to the Feulgen technique and were interpreted as nuclei by the authors, were observed in *Actinomyces viridis* Millard & Burr (a species obtained from the National Type Culture Collection, London, England) and in six isolates of *Actinomyces*, which are designated by the numbers 2, 4, 7, 30, 35, and 36. Nos. 4 and 30 were isolated from soil (East Lansing, Michigan), Nos. 2, 35, and 36 from *Actinomyces* scab lesions on potato tubers (Lake City, Michigan), and No. 7 was taken from a scab lesion on a turnip root (East Lansing).

It is of interest to add that the staining of bodies identical in morphology and position was observed with methylene blue in smears with an albumin fixative, killed with 95 per cent ethyl alcohol and differentiated with 95 per cent alcohol.

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DESMIDS OF ISLE ROYALE, MICHIGAN  
THE GENERA STAUSTRUM, MICRASTERIAS,  
XANTHIDIUM, AND EUASTRUM, WITH  
A NOTE ON SPINOCLOSTERIUM

GERALD W. PRESCOTT

**I**N EARLIER papers (7, 8) the author published lists of desmids from Isle Royale, Michigan, together with some critical notes. A review of the literature dealing with Michigan algae indicates that there are no other reports on the desmid flora of the island. The latitude and other edaphic factors do not seem to influence the development of a flora different from that in southerly portions of Michigan from which desmid studies have been made (2, 3, 6, 9, 11). A number of species in the Isle Royale lists are, however, new records for the state.

Several related, or nearly related, genera are included in the present paper, which will be followed by a final report on remaining desmid species in Isle Royale collections. As previously mentioned (7), the samples from which these studies have been made were taken during the biological survey of the island authorized by the Fifty-fifth Legislature of the State of Michigan.

The author wishes to express his appreciation of a grant-in-aid from the American Association for the Advancement of Science. This is being used for the compiling of a desmid iconography, a set of records which is practically indispensable for a satisfactory taxonomic study of these plants. It has already proved to be of great help in the preparation of this and previous papers. The collection of figures, illustrating several thousands of species, is available for lending to students interested in the Desmidiaceae.

Only those species not listed or figured in the author's former papers on Isle Royale desmids are included here, except where critical remarks are called for.

## LIST OF SPECIES

## STAURASTRUM

*Staurastrum* is the largest, or nearly the largest, genus in the desmid family. Therefore one might expect it to be represented by more species than appear in the Isle Royale collections. The relatively small number of species and the fewness of the individuals may be accounted for by the manner in which the samples were obtained. According to field notes, no plankton-tow collections were made, and this is borne out by the fact that practically no plankton species of *Staurastrum* have been found in the samples. The genus lends itself to planktonic habits more easily than do other members of the family except the filamentous forms. The occurrence of certain *Staurastrum* species in open water, sometimes in great abundance, is made possible by the extension of the cell wall, especially at the angles, into long arms and processes, which of course lend buoyancy to the plant. If plankton samples had been taken no doubt many of the free-floating species, such as those which have been reported from Wisconsin lakes (10), would be found.

*STAURASTRUM ALTERNANS* De Bréb., Smith, *Phytoplankton Inland Lakes Wis.*, Part II, 70, Pl. 68, Fig. 4. 1924.

Width 35–36  $\mu$ , length 35  $\mu$ , isthmus 8.2  $\mu$ . Pl. I, Figs. 8–9  
Hidden Lake, Scoville Point, Siskowit Outlet Brook

*STAURASTRUM ARACHNE* Ralfs, Smith, *Phytoplankton Inland Lakes Wis.*, Part II, 111, text figure 13. 1924. Forma

Width 41  $\mu$ , length 21  $\mu$ , isthmus 7.8  $\mu$ . This is another expression of the species, the typical form having been previously recorded (7, Pl. 19, Figs. 13–14). It seems to be nearest var. *curvatum* W. & G. S. West in its proportions, but it is smaller, the arms are shorter, and there is no outward divergence. My specimens are always four-rayed in vertical view and do not have the marginal granules characteristic of the typical form. Pl. III, Figs. 15–16. Moose Lake

*STAURASTRUM ARCTICON* (Ehr.) Lund; Smith, *Phytoplankton Inland Lakes Wis.*, Part II, 124, Pl. 84, Figs. 1–2. 1924

Width 118  $\mu$  with processes, length 120  $\mu$  with processes, isthmus 28  $\mu$ . Pl. II, Fig. 1. Moose Lake

*STAURASTRUM AVICULA* De Bréb.; West and West, and Carter, *British Desmidiaceae*, V: 40, Pl. 133, Figs. 8–10. 1923.

Width 31.2  $\mu$ , length 21.4  $\mu$ , isthmus 7.8  $\mu$ . Pl I, Fig 21  
Moose Lake, pool at Scoville Point

**STAURASTRUM BRACHIATUM** Ralfs, West and West, and Carter,  
*British Desmidiaceae*, V. 88, Pl 141, Figs 14-15, Pl 142, Figs  
1-7 1923

Width 28  $\mu$ , length 23.4  $\mu$ , isthmus 9  $\mu$  Pl I, Figs 13-15.  
Moose Lake

**STAURASTRUM BREBISSEANII** Arch ; West and West, and Carter,  
*British Desmidiaceae*, V 61, Pl 137, Figs 4-5 1923

Width 58.5  $\mu$  without spines, length 62.4  $\mu$  without spines,  
isthmus 19.5  $\mu$  Except for the smaller size of my specimens they  
are similar to var *maximum* Cedercreutz This plant should be  
compared with the smaller species *S pilosum* (Naeg.) Arch Pl  
II, Fig 4 Damp soil, Passage Island.

**STAURASTRUM CAPITULUM** var **SPETSBERGENSE** (Nordst.) Cooke,  
West and West, *British Desmidiaceae*, IV 126, Pl 118, Fig 8  
1912

Width 31.5  $\mu$ , length 50.7  $\mu$ , isthmus 18  $\mu$  Previously re-  
ported (7) but not figured Pl II, Figs 5-7 Dripping cliff,  
Passage Island

**STAURASTRUM CRENULATUM** (Naeg.) Delp, West and West, and  
Carter, *British Desmidiaceae*, V 110, Pl 143, Figs 9-13 1923

Width 35  $\mu$ , length 23.4  $\mu$ , isthmus 9.7  $\mu$  Pl. II, Fig 10.  
Wallace Lake. Abundant New record for Michigan.

**STAURASTRUM DEJECTUM** De Bréb, Smith, *Phytoplankton Inland  
Lakes Wis*, Part II 73, Pl 68, Figs 18-24 1924

Width 19.5  $\mu$ , length 19  $\mu$  without spines, isthmus 5-8  $\mu$   
Pl. I, Fig. 18 Hidden Lake

**STAURASTRUM DICKIEI** Ralfs, West and West, and Carter, *British  
Desmidiaceae*, V. 3, Pl 124, Figs 14-15 1923

Width 62  $\mu$ , length 35  $\mu$ , isthmus 9.5  $\mu$ . Pl II, Figs 8-9  
Common in Hidden Lake

**STAURASTRUM DICKIEI** var **CIRCULARE** Turn, West and West, and  
Carter, *British Desmidiaceae*, V. 5, Pl 129, Fig 16 1923

Width 46.8  $\mu$ , length 62.6  $\mu$ , isthmus 13.6  $\mu$  Pl II, Figs 15-  
16. Moose Lake.

**STAURASTRUM DICKIEI** var. **MAXIMUM** W & G. S West; Smith,  
*Phytoplankton Inland Lakes Wis*, Part II 76, Pl 70, Figs 3-5.  
1924.

Width 72  $\mu$ , length 45.6  $\mu$ , isthmus 11.4  $\mu$  My specimens have less convergent spines than are usually found in this variety Pl II, Fig 17 Moose Lake.

**STAURASTRUM DILATATUM** var **HIBERNICUM** W & G S West, *British Desmidiaceae*, IV 175, Pl 136, Fig 18 1912

Width 24  $\mu$ , length 22.5  $\mu$ , isthmus 7.5  $\mu$  Pl I, Figs 16-17 Sphagnum bogs, Scoville Point New record for Michigan

**STAURASTRUM FURCIGERUM** De Bréb , West and West, and Carter, *British Desmidiaceae*, V 188, Pl 156, Figs 7-8, 11 1923

Width 50  $\mu$  with arms, length 54  $\mu$  with arms, isthmus 11.7  $\mu$  Pl III, Figs 1-2 Hidden Lake, Moose Lake, Wallace Lake

**STAURASTRUM GLADIOSUM** Turn , West and West, and Carter, *British Desmidiaceae*, V 57, Pl 137, Figs 1-2 1923

Width 48.7  $\mu$  with spines, 44  $\mu$  without spines, length 44.8  $\mu$ , isthmus 17.5  $\mu$  Pl III, Figs 7-8 Hidden Lake, Moose Lake

**STAURASTRUM HEXACERUM** (Ehr) Wittr , West and West, and Carter, *British Desmidiaceae*, V 138, Pl 142, Figs 11-14 1923

Width 35  $\mu$ , length 27.3  $\mu$ , isthmus 9.7  $\mu$  Pl II, Figs 18-19 Siskowit Lake

**STAURASTRUM IOTANUM** Wolle, West and West, and Carter, *British Desmidiaceae*, V 121, Pl 149, Fig 1 1923

Width 15  $\mu$ , length 15  $\mu$ , isthmus 7  $\mu$  Pl III, Fig 12 Hidden Lake, Moose Lake Infrequent in Isle Royale collections

**STAURASTRUM LEPTOCLADUM** Nordst , Smith, *Phytoplankton Inland Lakes Wis*, Part II 107, Pl 78, Figs. 1 7 1924

Width 74.1  $\mu$ , length 39  $\mu$ , isthmus 8  $\mu$  Pl III, Fig 3 Moose Lake

**STAURASTRUM LEPTOCLADUM** var **INSIGNE** W & G S West; Smith, *Phytoplankton Inland Lakes Wis*, Part II 103, Pl 77, Fig 15; Pl 78, Figs 8-11 1924

Width 83.6  $\mu$ , length 45.6  $\mu$ , isthmus 10.5  $\mu$  My specimens are a little small Pl III, Figs 4-6 Moose Lake. New record for Michigan

**STAURASTRUM LUNATUM** Ralfs, West and West, and Carter, *British Desmidiaceae*, V. 29, Pl. 133, Figs 17-19. 1925

Width 24  $\mu$ , length 28  $\mu$ , isthmus 8  $\mu$  Pl II, Figs 20-21. Bat Island New record for Michigan

**STAURASTRUM MAAMENSE** Arch , West and West, and Carter, *British Desmidiaceae*, V: 75, Pl 139, Fig. 10. 1923

Width 30.4  $\mu$ , length 34.2  $\mu$ , isthmus 13.2  $\mu$  Reported but not figured (7, p 208) Pl III, Fig 9 Moose Lake

**STAUROSTRUM MARGARITACEUM** var **ROBUSTUM** W & G S West, West and West, and Carter, *British Desmidiaceae*, V 133, Pl 150, Fig 13 1923

Width 26.6  $\mu$ , length 29.2  $\mu$ , isthmus 7.5  $\mu$  Pl II, Figs 2-3 Hidden Lake New record for North America

**STAUROSTRUM MINNESOTENSE** Wolle, Smith, *Phytoplankton Inland Lakes Wis*, Part II 81, Pl 71, Figs 14-15 1924

Width 166-170  $\mu$  with spines, length 123.5  $\mu$  with spines, isthmus 40.5  $\mu$  This appears to be a ubiquitous species, having been found in subalpine regions of western United States as well as in southern Louisiana, in the bogs of northern United States, and in Canada Pl II, Figs 11-12 Moose Lake

**STAUROSTRUM MUTICUM** De Bréb, West and West, *British Desmidiaceae*, IV 133, Pl 118, Figs 16-20 1912

Width 35.2  $\mu$ , length 37  $\mu$ , isthmus 8.5  $\mu$  Pl IV, Figs 7-8 Moose Lake

**STAUROSTRUM ORBICULARE** var **DEPRESSUM** Roy et Biss, West and West, *British Desmidiaceae*, IV 158, Pl 124, Figs 17-19 1912

Width 24  $\mu$ , length 22.8  $\mu$ , isthmus 7.8  $\mu$  Pl III, Fig 11 Moose Lake

**STAUROSTRUM ORBICULARE** var **HIBERNICUM** W & G S West, *British Desmidiaceae*, IV 156, Pl 124, Figs 5-9 1912

Width 42  $\mu$ , length 46.8  $\mu$ , isthmus 15.6  $\mu$  Pl III, Fig 21 Moose Lake

**STAUROSTRUM ORBICULARE** var **truncatum**, var nov<sup>1</sup>

Cells much larger than in the type, semicells with broadly rounded basal angles, with upper lateral margins straighter than in the type, and with apex broadly truncate, in vertical view triangular, the angles broadly rounding, sides slightly concave, cell wall smooth Width 60-63  $\mu$ , length 70-74.5  $\mu$ , isthmus 17-19.5  $\mu$  Pl III, Figs 14, 20 Moose Lake.

**STAUROSTRUM PACHYRHYNCHUM** Nordst., Taylor, "Fresh-Water

<sup>1</sup> *Staurastrum orbiculare* var *truncatum*, var nov — Cellulae in varietate multo majores quam in typo; semicellulae angulis inferioribus late rotundatis, marginibus laterahbus superioribus directioribus quam in typo, apice late truncato, de vertice visae triangulares, angulis late rotundatis, lateribus subconcavis, membrana glabra. Lat 60-63  $\mu$ , long 70-74.5  $\mu$ , isth 17-19.5  $\mu$ .

Algae of Newfoundland, Part II," *Pap Mich Acad Sci, Arts, and Letters*, 20. 195, Pl 34, Fig 1 1935.

Width 32  $\mu$ , length 35  $\mu$ , isthmus 7.8  $\mu$  Pl. III, Fig 13.  
Moose Lake

**STAURASTRUM PARADOXUM** var **PARVUM** West, West and West, and Carter, *British Desmidiaceae*, V 106, Pl 145, Fig 6 1923

Width 24  $\mu$ , length 21  $\mu$  Pl III, Fig 17 Hidden Lake

**STAURASTRUM PENTACERUM** (Wolle) G M Smith, Smith, *Phytoplankton Inland Lakes Wis*, Part II. 112, Pl 80, Figs 15-18 1924 Forma

Width 87  $\mu$ , length 49.4  $\mu$ , isthmus 15.2  $\mu$  This plant combines some characteristics of *S. pentacerum* (Wolle) G M. Smith and *S. Ophura* Lund It has the proportions of the latter but the size of the former, and, as in the former, the bases of the semicells are devoid of spines It seems better to assign it to this species Pl IV, Fig 2 Moose Lake

**STAURASTRUM POLYTRICHUM** Perty, West and West, and Carter, *British Desmidiaceae*, V. 53, Pl 136, Figs. 8-10 1923

Width 58.5  $\mu$ , length 53  $\mu$ , isthmus 17  $\mu$  Common in several collections

**STAURASTRUM PSEUDOSEBALDI** Wolle, West and West, and Carter, *British Desmidiaceae*, V. 113, Pl 166, Fig. 4 1923 Forma

Width 57  $\mu$ , length 39  $\mu$ , isthmus 12  $\mu$  This seems to belong here, but our specimens are smaller than the size usually recorded for the typical expression. Pl. IV, Figs 3-4 Moose Lake

**STAURASTRUM PUNCTULATUM** De Bréb, West and West, *British Desmidiaceae*, IV 179, Pl 127, Figs. 8-11, 13-14 1912

Width 21.4  $\mu$ , length 21.4  $\mu$ , isthmus 11.7  $\mu$  Pl III, Figs 18-19 Bat Island

**STAURASTRUM ROTULA** Nordst, Smith, *Phytoplankton Inland Lakes Wis.*, Part II. 116, Pl 81, Figs 5-8 1924

Width 64.3  $\mu$ , length 46.5  $\mu$ , isthmus 12  $\mu$ . Pl. IV, Figs 5-6 Moose Lake New record for Michigan.

**STAURASTRUM RUGULOSUM** De Bréb, West and West, *British Desmidiaceae*, IV 178, Pl 126, Fig 3 1912

Width 37  $\mu$ , length 35  $\mu$  West and West suggest that this is an expression of *S. alternans* De Bréb and question its validity. Our specimens seem to have much in common with *S. alternans*, and they should be compared. Pl. IV, Fig 1 Moose Lake

**STAUSTRUM SEXCOSTATUM** var. **PRODUCTUM** West, West and West, and Carter, *British Desmidiaceae*, V 148, Pl 150, Fig 15. 1923.

Width 41.9  $\mu$ , length 44  $\mu$ , isthmus 17.5  $\mu$ . Pl III, Fig 22  
Soil on Passage Island New record for Michigan

**STAUSTRUM TETRACERUM** Ralfs, West and West, and Carter, *British Desmidiaceae*, V 118, Pl 149, Figs 2-4 1923

Cells very small, width 20-25  $\mu$ , length 23-26  $\mu$ , isthmus 4  $\mu$   
Pl IV, Fig 9. Moose Lake

**STAUSTRUM TOHOPEKALIGENSE** Wolle, Wolle, *Desmids of the United States*, p 164, Pl 47, Figs 4-5 1892 Forma.

Width 43.9  $\mu$  with arms, length 50.7  $\mu$  with arms, isthmus 15.6  $\mu$  My specimens showed another of the numerous variations common to this species They are somewhat unusual in that the apical processes are fewer (four) than the lateral (six) The reverse situation is the more common arrangement Pl II, Figs 13-14 Moose Lake

#### MICRASTERIAS

**MICRASTERIAS AMERICANA** var **BOLDII** Gutw , West and West, *British Desmidiaceae*, II. 120, Pl 53, Fig 6 1905

Width 97.5  $\mu$ , length 113.2  $\mu$ , isthmus 27.3  $\mu$  Because of the denticulate apices of the lobules the Isle Royale specimens bear a resemblance to var *Lewisiana* West Pl III, Fig 10 Siskowit Lake

**MICRASTERIAS APICULATA** (Ehr ) Menegh , West and West, *British Desmidiaceae*, II. 97, Pl. 47, Figs 1-2 1905

Width 120.9  $\mu$ , length 124.8  $\mu$ , isthmus 31.2  $\mu$  Pl IV, Fig 14  
Hidden Lake.

**MICRASTERIAS CRUX-MELITENSIS** (Ehr ) Hass , West and West, *British Desmidiaceae*, II 116, Pl. 53, Figs 1-3. 1905

Width 105  $\mu$ , length 117  $\mu$ , isthmus 17.5  $\mu$  Pl IV, Fig 10  
Hidden Lake

**MICRASTERIAS LATICEPS** Nordst , Smuth, *Phytoplankton Inland Lakes Wis* , Part II. 41, Pl. 59, Fig 3. 1924

Width 152  $\mu$ , length 136.5  $\mu$ , isthmus 23.4  $\mu$  Pl IV, Fig. 17.  
Hidden Lake

**MICRASTERIAS PAPILLIFERA** De Bréb ; West and West, *British Desmidiaceae*, II : 91, Pl 44, Figs 1-2, 7 1905



Width 113  $\mu$ , length 117  $\mu$ , isthmus 23.4  $\mu$  Pl IV, Fig 16  
Moose Lake

*MICRASTERIAS PINNATIFIDA* (Kuetz) Ralfs, West and West, *British Desmidiaceae*, II 80, Pl 41, Figs 7-11, 13 1905

Width 55-60  $\mu$ , length 55-65  $\mu$ , isthmus 16  $\mu$  Pl IV, Fig 12.  
Moose Lake

*MICRASTERIAS RADIATA* Hass, Smith, *Phytoplankton Inland Lakes Wis*, Part II 50, Pl 63, Fig 1 1924

Width 136.5  $\mu$ , length 156  $\mu$ , isthmus 19.5  $\mu$  Pl IV, Fig 13  
Moose Lake

*MICRASTERIAS ROTATA* (Grev) Ralfs, West and West, *British Desmidiaceae*, II 102, Pl 48, Figs 1-6 1905

Width 214.5  $\mu$ , length 234  $\mu$ , isthmus 33  $\mu$  Moose Lake

*MICRASTERIAS SOL* (Ehr) Kuetz, West and West, *British Desmidiaceae*, II 95, Pl 46, Figs 1-2 1905

Width 138.4  $\mu$ , length 148.2  $\mu$ , isthmus 11.7  $\mu$  Moose Lake

#### XANTHIDIUM

*XANTHIDIUM ANTILOPAEUM* (De Bréb) Kuetz, Smith, *Phytoplankton Inland Lakes Wis*, Part II 57, Pl 65, Figs 5-6 1924.

Width 58.5  $\mu$  with spines, length 54.6  $\mu$  with spines, isthmus 13.6  $\mu$  Moose Lake

*XANTHIDIUM ANTILOPAEUM* var *POLYMAZUM* Nordst, Smith, *Phytoplankton Inland Lakes Wis*, Part II 58, Pl 65, Figs 7-9 1924.

Width 70.2  $\mu$  with spines, length 66.3  $\mu$  with spines, isthmus 15.6  $\mu$  Pl IV, Fig 15 Moose Lake

*XANTHIDIUM CRISTATUM* var *UNCINATUM* De Bréb, Smith, *Phytoplankton Inland Lakes Wis*, Part II 60, Pl 66, Fig 4 1924

Width 41.8  $\mu$  without spines, 55  $\mu$  with spines, length 57.5  $\mu$  without spines, 73.4  $\mu$  with spines; isthmus 18  $\mu$  Pl IV, Fig 11.  
Moose Lake.

#### EUASTRUM

This interesting genus is fairly well represented in Isle Royale collections and includes a number of large and very beautiful species. Of the group nearly all have been listed in a previous account (7). Additions to the list already published and a few forms from the previous report which seem to merit illustration are included here

**EUASTRUM AFFINE** Ralfs, Krieger, *Die Desmidiaceen*, Lief 3 520, Pl 68, Figs 2-4 1937

This species has a large median mucilage pore. The wall is coarsely scrobiculate at the angles of the cell. Width  $62.4\ \mu$ , length  $117\ \mu$ , isthmus  $19.5\ \mu$ . Pl I, Fig 1. Moose Lake.

**EUASTRUM ATTENUATUM** var **LITHUANICUM** Krieger, *Die Desmidiaceen*, Lief 4 542, Pl 73, Figs 18-19 1938. Forma

Width  $35.1\ \mu$ , length  $59.5\ \mu$ , thickness  $23.4\ \mu$ , isthmus  $11.7\ \mu$ .

This interesting form of *E. attenuatum* is characterized by a much broader and stouter apical lobe than that of the typical plant and by basal lobes with a deep lateral emargination. The basal lobes are coarsely granular at the margins, and the apex is beset with heavier folds than appear in the typical form. Pl I, Figs 2-4. Hidden Lake. New record for North America.

**EUASTRUM CRASSUM** var **SCROBICULATUM** Lund, Krieger, *Die Desmidiaceen*, Lief 3 512, Pl 65, Figs 2-5 1937

This species has a large median pore which sometimes is not shown in published figures of the plant. Width  $74.2\ \mu$ , length  $156.4\ \mu$ , isthmus  $16-24\ \mu$ . Pl I, Fig 10. Hidden Lake.

**EUASTRUM INCRASSATUM** Nordst., Krieger, *Die Desmidiaceen*, Lief 4 582, Pl 85, Figs 16-18 1938

Width  $25.5\ \mu$ , length  $39\ \mu$ , isthmus  $11.4\ \mu$ . Our specimens show two basal granules rather than one as in the typical expression. Pl I, Figs 5-7. Moose Lake. New record for North America.

**EUASTRUM PECTINATUM** De Bréb., Krieger, *Die Desmidiaceen*, Lief 3 536, Pl 72, Figs 4-7 1937. Forma

The nodules on the face of the semicell are comparable to the typical form, but the apical lateral angles are not extended. In side view my specimens show a much thicker cell, with protuberances or swellings on the upper lateral margins and another swelling at the basal lateral margins. There is so much variation and intergrading among the individuals in the Isle Royale collections that new variety names do not seem warranted. Width  $48.7\ \mu$ , length  $66.3\ \mu$ , isthmus  $9.7\ \mu$ . Pl I, Figs 11-12. Another form is shown in Pl I, Fig 19. Moose Lake.

**EUASTRUM PECTINATUM** var **BRACHYLOBUM** f. **ROSTRATUM** Taylor; Krieger, *Die Desmidiaceen*, Lief 4 539, Pl 73, Figs 4-5 1938

Width 44.8  $\mu$ , length 70  $\mu$ , isthmus 12  $\mu$  Pl I, Fig 20 Hidden Lake New record for Michigan

*EUASTRUM PECTINATUM* var *scrobiculatum*, var nov<sup>2</sup>

Variety with apical lobe short, the apices convex, and with a deep emargination in the lateral walls of the basal lobes, wall coarsely scrobiculate, two large tuberculations within the margin of the basal lobules, side view subquadrangular, a large median tuberculation on the lateral margins and a smaller one just below it on the basal angles Width 47-49.4  $\mu$ , length 73-76.4  $\mu$ , isthmus 15.2  $\mu$  Pl I, Fig 22 Moose Lake

*EUASTRUM VENTRICOSUM* Lund, West and West, *British Desmidiaceae*, II: 4, Pl 33, Figs 1-3. 1909 Forma

Width 87.7  $\mu$ , length 138.4  $\mu$ , isthmus 23.4  $\mu$  The apical lobe in our specimens is more truncate, the upper lateral angles are more produced than in the typical form, and the sinus between the upper and the lateral lobules is more open Moose Lake

SPINOCLOSTERIUM

In an earlier paper (7, p 203) the author described what was considered to be a new genus (*Closterioides*) in the *Desmidiaceae*. Since the publication of that paper he has found it to have been previously described by Bernard (1, p. 31, Fig 35) as *Spinoclosterium*. The writer has been fortunate in seeing the living plant a number of times in collections taken from bog lakes in northern Wisconsin. The desmid-like features which were not altogether convincing as seen in the preserved specimens in the Isle Royale collections have been definitely confirmed. The terminal vacuoles, for example, were quite clear in the living plants. Dr C. E. Taft reports by correspondence that he has found this desmid in the Lower Peninsula of Michigan. It appears to be, therefore, a definite species with a wide geographical distribution, and is not, as has been intimated, an aberrant or abnormal form of some other desmid. Whether the plant should be assigned to a section of the genus *Closterium* is a debatable question. The spiny character of the wall seems to the writer to

<sup>2</sup> *Euastrum pectinatum* var *scrobiculatum*, var. nov. — Varietas lobo apicali brevi, apicibus convexis, parietibus lateralibus loborum inferiorum profunde emarginatis; pariete crasse scrobiculato; tuberculis duobus magnis intra loborum inferiorum marginem; a latere visa subquadrangularis, tuberculo mediano magno in marginibus lateralibus aito, secundo minore paulo infra hoc posito in angulis inferioribus. Lat. 47-49.4  $\mu$ , long. 73-76.4  $\mu$ , isthmus 15.2  $\mu$

be sufficient justification for removal from that genus. The North American specimens are a little stouter ( $58-62\ \mu$  as compared with  $47-52\ \mu$ ) than the specimens described by Bernard (1). Also, in the Michigan plants spines are stouter and longer, and there is a distinct swelling of the apices, which apparently is not true for the Malay specimens. The concretions on the wall may or may not be of significance. They appear on the older half of all the specimens which the author has seen. *Closterioides spinosum* Prescott (7, p. 203, Pl. XIX, Figs. 1-3) is reduced to synonymy as follows: *Spinoclosterium curvatum* var. *spinosum* nob.

ALBION COLLEGE  
ALBION, MICHIGAN

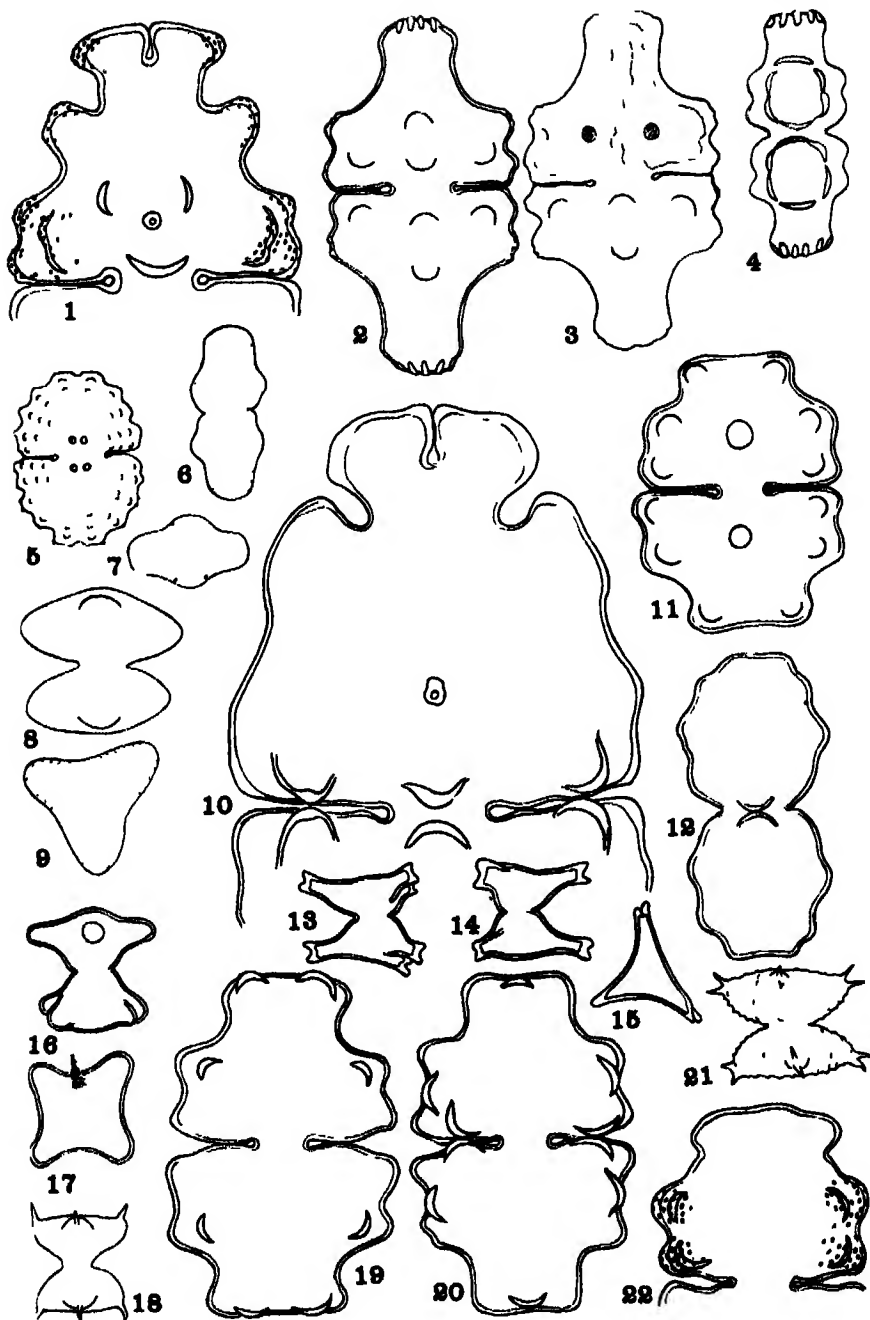
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- 15 WOLLE, REV FRANCIS 1892 Desmids of the United States and List of  
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### EXPLANATION OF PLATE I

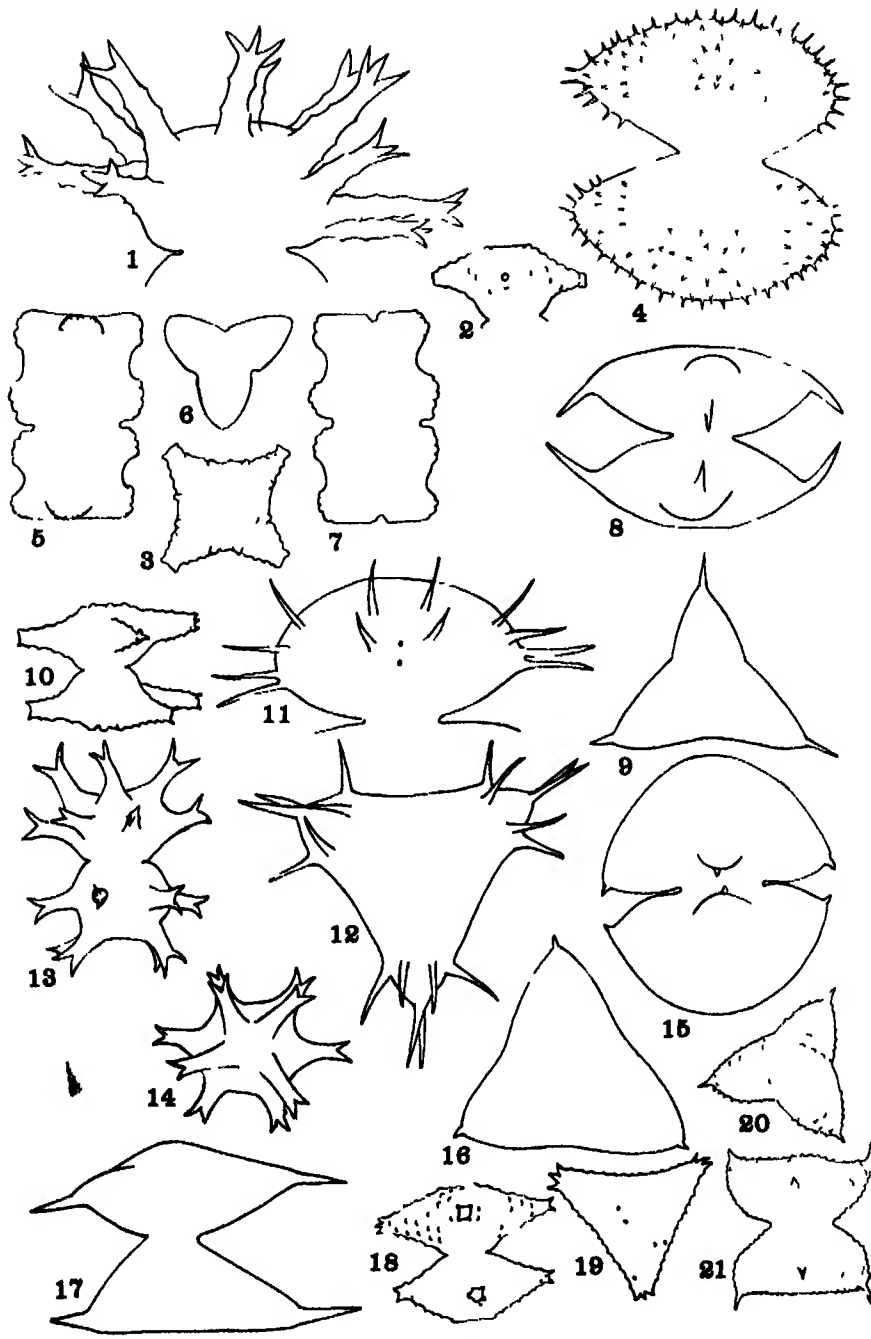
- 1 Euastrum affine Ralfs × 440
- 2-4 E attenuatum var lithuanicum Krieger, f × 600
- 5-7 E incrassatum Nordst × 440 (Fig 6 after W & G S West)
- 8-9 Staurastrum alternans De Bréb × 440
- 10 Euastrum crassum var scrobiculatum Lund × 440
- 11-12 E pectinatum De Bréb, f × 440
- 13-15 Staurastrum brachiatum Ralfs × 440
- 16-17 S dilatatum var hibernicum W & G S West × 600
- 18 S dejectum De Bréb × 480
- 19 Euastrum pectinatum De Bréb, f × 440
- 20 E pectinatum var brachylobum f rostratum Taylor × 440
- 21 Staurastrum avicula De Bréb × 440
- 22 Euastrum pectinatum var scrobiculatum, var nov × 440



Desmids of Isle Royale

## EXPLANATION OF PLATE II

- 1    *Staurostrum Aretiscum* (Fhr.) Lund    × 440
- 2-3   *S. margaritaceum* var. *robustum* W & G S West    × 440
- 1    *S. Brebissoni* Arch    × 440
- 5-7   *S. Capitulum* var. *sprengeri* (Nordst.) Cooke    × 440
- 8-9   *S. Dickiei* Ralfs    × 482
- 10    *S. crenulatum* (Naeg.) Delp    × 440
- 11-12   *S. minnesotense* Wolln    × 265
- 13-14   *S. tohopekaligense* Wolln, f    × 440
- 15-16   *S. Dickiei* var. *circularis* Tun    × 440
- 17    *S. Dickiei* var. *maximum* W & G S West    × 440
- 18-19   *S. hexactum* (Ehr.) Wittl., Fig 18, × 440, Fig 19 (after W & G S West), × 390
- 20-21   *S. lunatum* Ralfs    × 440

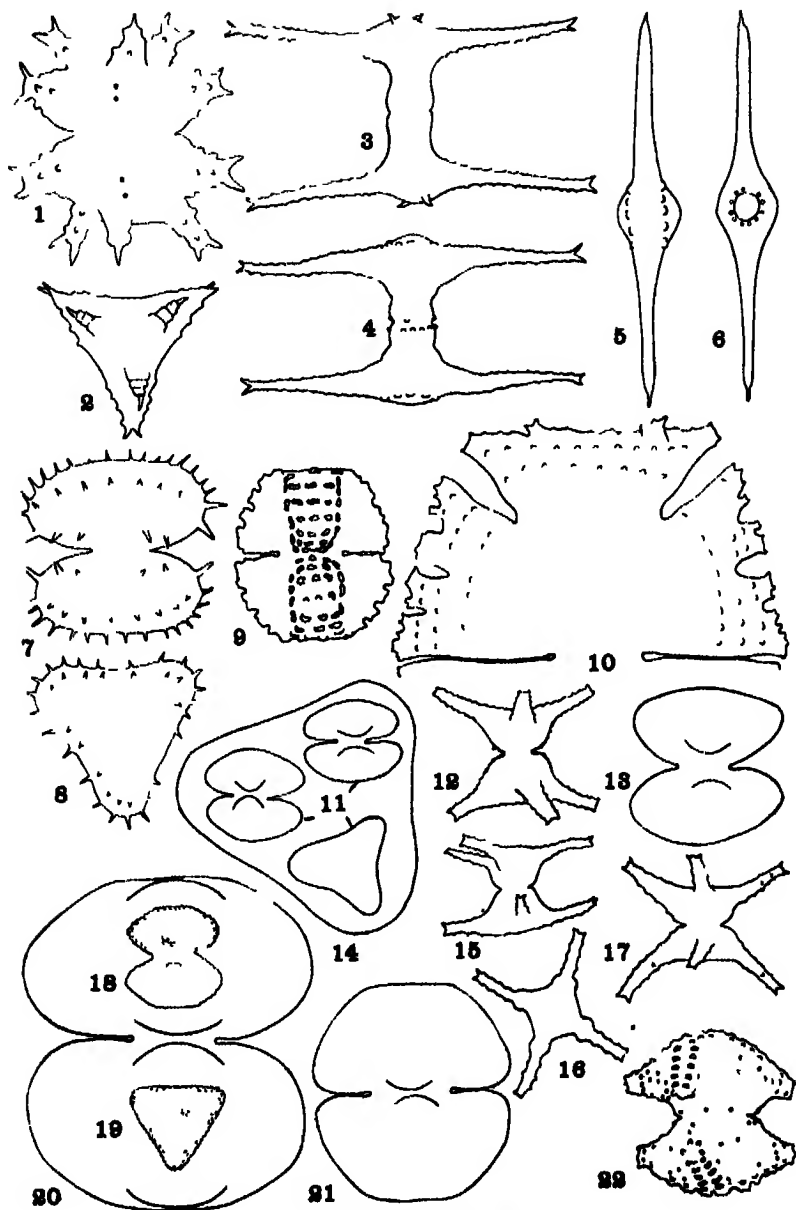


Desmids of Isle Royale



# EXPLANATION OF PLATE III

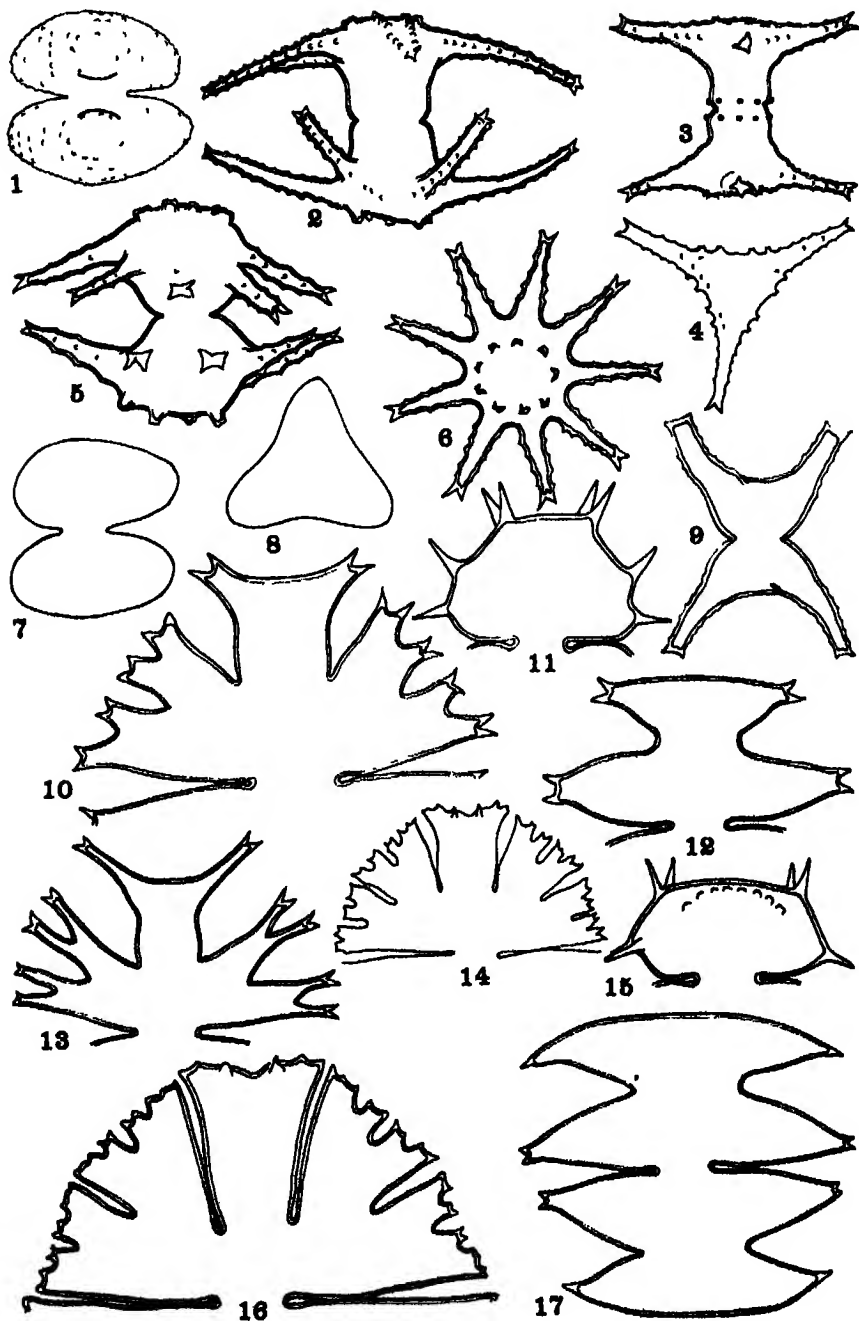
- 1-2 *Stauroastrum furcigerum* De Bréb    × 440
- 3 *S leptocladum* Nordst    × 440
- 4-6 *S leptocladum* var *insigne* W & G S West    × 440
- 7-8 *S gladiosum* Turm    × 440
- 9 *S maanenense* Arch    × 440
- 10 *Micrasterias americana* var *Boldti* Gutw    × 440
- 11 *Stauroastrum orbiculare* var *depressum* Roy et Biss    × 440
- 12 *S iotatum* Wolle    × 1900
- 13 *S pachyrhynchum* Nordst    × 440
- 14, 20 *S orbiculare* var *truncatum*, var *nov*    × 440
- 15-16 *S arachne* Ralfs, f    × 440
- 17 *S paradoxum* var *parvum* West    × 600
- 18 19 *S punctulatum* De Bréb    × 440
- 21 *S orbiculare* var *hibernicum* W & G S West    × 440
- 22 *S sexcostatum* var *productum* West    × 440



Desmids of Isle Royale

## EXPLANATION OF PLATE IV

- 1 *Staurostrum rugulosum* De Bréb    × 440
- 2 *S pentacerum* (Wolle) G M Smith, f    × 440
- 3-4 *S Pseudosebaldi* Wolle, f    × 440
- 5-6 *S rotula* Nordst    × 440
- 7-8 *S muticum* De Bréb    × 440
- 9 *S tetracerum* Ralfs    × 440
- 10 *Micrasterias Crux-melitensis* (Ehr ) Hass    × 440
- 11 *Nanthidium cristatum* var *uncinatum* De Bréb    × 440
- 12 *Micrasterias pinnatifida* (Kuetz ) Ralfs    × 440
- 13 *M radiata* Hass    × 282
- 14 *M apiculata* (Ehr ) Menegh    × 220
- 15 *Nanthidium antilopaeum* var *polymazum* Nordst    × 330
- 16 *Micrasterias papillifera* De Bréb    × 440
- 17 *M laticeps* Nordst    × 220



Desmids of Isle Royale



## NOTES ON BRYOPHYTES OF CENTRAL MICHIGAN

IRMA SCHNOOBERGER

**A**MONG the bryophytes collected in central Michigan by the writer from September, 1937, to January, 1939, are four species not previously reported from the state and a number of noteworthy range extensions of species within the state. The new species are indicated by an asterisk, and range extensions are given with each species.

All previous lists of Michigan bryophytes have been from collections made in the southern part of the state, chiefly around Ann Arbor, or from the northern part of the Lower Peninsula, Douglas Lake and Glen Lake, or from the Upper Peninsula and Isle Royale.

Central Michigan embraces an area offering various types of collecting grounds for the bryologist, though until very recently no one had done any bryological investigation in them. Much of the land is under cultivation, but great areas unfit for farming have been allowed to go back to woodland or have been reforested. Many of these woodlands or forests are of second-growth beech and maple, more or less open and on comparatively high, dry ground. Where the soil is lighter and poorer, extensive areas are covered with aspens, but there are occasional oaks or pines. Lakes are numerous, and marshes and bogs are plentiful. The lakes may have gravelly or sandy shores gradually sloping up to wooded ground or may be bounded by marshes, either open or partly wooded with cedar or tamarack or with a few elms and tag alders. Near Croton, in Newaygo County, there is a veritable desert of shifting sands with very sparse vegetation, just a few miles to the southeast, in Mecosta County, occur sandy plains spotted with pine and oak; at the tip of the "Thumb," in Huron County, are rocky shore lines and fair-sized sandstone cliffs. Each of these localities has a more or less distinct type of flora. In the cedar and cedar-tamarack swamps and bogs northern species occur, and in low marshes or open plains and farming country are found those previously reported only from

much farther south Hence many appreciable northern or southern extensions of range have been noted

In the classification of the species of mosses A J Grout's *Moss Flora of North America North of Mexico* has been followed Unless otherwise stated, the determinations were made by the writer Appreciation is expressed to Dr W C Steere, who has verified all determinations

In the list following only the wider extensions of range have been noted, the general habitat of each species is given Duplicate specimens are on file in the University of Michigan Herbarium All records reported are based on collections made by the writer

### LIST OF SPECIES

#### RICCIACEAE

**RICCIOCARPUS NATANS** (L) Corda — Terrestrial form Growing over ground and old stumps in marshy lowland that dries out during the summer, south of Alma, Gratiot County This is a northern extension of range from Washtenaw County

#### RICCARDIACEAE

**RICCARDIA LATIFRONS** Lindb — On rotten stumps in cedar woods and swamps, Montcalm County Southern extension from Glen Lake and Douglas Lake

#### LOPHOZIACEAE

**LOPHOZIA INCISA** (Schedr) Dumort — Growing over mosses on rocky ledge along lake shore, Port Austin, Huron County Southern extension from Douglas Lake

#### JUNGERMANNIACEAE

**CEPHALOZIA BICUSPIDATA** (L) Dumort — In open woods on rotten wood and logs; Port Austin, Huron County, and north of Long Lake, Clare County First report for the Lower Peninsula Common in the Upper Peninsula and reported from Isle Royale.

#### LEJEUNEACEAE

**FRULLANIA ASAGRAYANA** Mont — On trees in cedar swamp north of Long Lake, Clare County Southern extension from Isle Royale, the Upper Peninsula, and the Douglas Lake region.

**FRULLANIA BRITTONIAE** Evans — On trunks of live maples and elms in open woods, Gratiot and Montcalm counties Southern extension from the Upper Peninsula, and the Douglas Lake region

\***FRULLANIA INFLATA** Gottsche — Determined by Dr A W Evans Collected by Dr Steere in Washtenaw County and by the writer in Ionia County in the spring of 1938 Writer's specimen taken from base of poplar tree on bank of creek

**FISSIDENTACEAE**

**FISSIDENS JULIANUS** (Mont) Schimp — Very abundant in intermittent creek bed; eastern Gratiot County Previously known in the state only from Washtenaw County

**DICRANACEAE**

**BRUCHIA SULLIVANTI** Aust — Old sandy meadows, Van Buren County. Westward extension from Calhoun and Kalamazoo counties, where it was collected by Mr Becker

**PLEURIDIUM SUBULATUM** (Hedw) Lindb — Old sandy meadows, Van Buren and Gratiot counties Western and northern extension from Kalamazoo County

**ONCOPHORUS WAHLENBERGII** Brid — Over soil and rotten wood in cedar swamps, Clare and Montcalm counties Southern extension from Glen and Douglas lakes.

**DICRANUM MONTANUM** Hedw — Bases of trees in low wet woods, Huron and Gratiot counties Southern extension from Glen and Douglas lakes.

**EPHEMERACEAE**

**EPHEMERUM SPINULOSUM** Schimp. — In sandy hillside meadow south of Alma, Gratiot County Northern extension from Kalamazoo, Calhoun, and Washtenaw counties

**BARBULA CONVOLUTA** Hedw. — Determined by Dr W. C Steere Sandy roadside ditch west of Ionia, Ionia County Southern extension from Douglas Lake and the Upper Peninsula

**TORTELLA FRAGILIS** (Drumm) Limpr. — Common on rocky ledges along shore of Lake Huron, Port Austin, Huron County. Southern extension from the Douglas Lake region.



**TORTELLA TORTUOSA** (Turn) Limpr — Plentiful on rocks at Broken Rocks, Port Austin, Huron County Southern extension from Glen and Douglas lakes

**TORTULA OBTUSIFOLIA** Schleich (*Desmatodon arenaceus* S & L) — On rocks along lake front Common at Broken Rocks and Pointe aux Barques, Port Austin, Huron County Southern extension from northern tip of the Lower Peninsula

\***TORTULA PAPILLOSA** (Wils) Spruce — The first collection of this moss was made at Allegan, Allegan County, by the writer, and it was subsequently collected in Isabella, Gratiot, Montcalm, Ionia, Van Buren, and Ottawa counties Dr Steere located stations in Washtenaw and Livingston counties It seems to be common locally, growing on the exposed or sunny side of old elms or over the roots of elms with other mosses The material from Ottawa County was taken from *Celtis occidentalis* and *Salix* growing along Grand River All specimens from Michigan have been on trees near streams, rivers, or lakes

At first sight *T papillosa* resembles an *Orthotrichum*, but upon closer examination the shiny costa shows up in a characteristic manner, and if one moistens the leaves they uncurl and reveal the excurrent costa and the spatula-shaped leaf with the ever-present propagula on the upper portion of costa and leaf All these characters are easily seen with the aid of a hand lens

#### ORTHOTRICHACEAE

**ORTHOTRICHUM ANOMALUM** Hedw — Covering large rocks on steep exposed hillside overlooking Grand River, west of Ionia, Ionia County Fruiting freely Southern extension from the Douglas Lake region

#### MEESEACEAE

**PALUDELLA SQUARROSA** (L) Brid — Growing with *Sphagna* and *Camptothecium nitens* in cedar-tamarack swamp north of Vestaburg, Montcalm County Otherwise known from Isle Royale and Alger County This is the first station for the Lower Peninsula

#### BRYACEAE

**BRYUM CERNUUM** (Sw) Lindb (*Bryum uliginosum* (Bruch) Br. & Sch) — Determined by Dr Steere On high sandy bank overlooking Little Muskegon River, southeast of Croton, Mecosta

County In good fruit Known from the Douglas Lake region and Kalamazoo County

**BRYUM VENTRICOSUM** Dicks — In swampy woods and cedar swamps north of Long Lake, Clare County, and north of Vestaburg, Montcalm County Southern extensions from Douglas Lake and Isle Royale

#### LESKEACEAE

**THUIDIUM PHILIBERTI** Lampr. — Growing with other mosses over rotten logs in cedar swamps east of Gaylord, Otsego County, and west of Elmhall, Montcalm County Previously known from Isle Royale and the Porcupine Mountains

**LESKEA OBSCURA** Hedw — Bases of trees in open woods, Gratiot County In fine fruit Northern extension from Van Buren County

**ANOMODON TRISTIS** (Cesati) Sull — Base of tree in low, open woods west of Elm Hall, Montcalm County A very small moss and evidently not common, since only one collection has been made so far Previously known only from the Huron Mountains

**MYURELLA JULACEAE** (Vill) Br & Sch — Common on rock ledges along lake shore, Port Austin, Huron County Also known from the rocky shores of the Upper Peninsula and the Douglas Lake region

#### HYPNACEAE

**BRACHYTEDIUM ACUTUM** (Mitt) Sull — In cedar swamp east of Gaylord, Otsego County, and in low open woods just back from lake shore, Port Austin, Huron County Previously known only from Washtenaw County.

**BRACHYTEDIUM CAMPESTRE** B & S — On bank in shaded ravine east of South Haven, Van Buren County Otherwise known from Washtenaw County and the Porcupine Mountain region

**BRACHYTEDIUM CYRTOPHYLLUM** Kindb — Common on the bases of trees in open woods, Isabella, Gratiot, Huron, and Ionia counties Southern extensions from the Douglas Lake region

\***BRACHYTEDIUM DIGASTRUM** C Muell & Kindb — Over wet logs near river southwest of Alma, Gratiot County Many setae left on plants but few capsules This is the first report for Michigan and so far the only station.

**BRYHIA NOVAE-ANGLIAE** (Sull & Lesq) Grout — Common locally in open woods, Gratiot and Van Buren counties Otherwise

known from Glen Lake and the Douglas Lake region, Grand Traverse County, and the Upper Peninsula

*EURYNCHIUM STRIGOSUM* (praecox) var *ROBUSTUM* Röll — In open moist woods, Mecosta and Van Buren counties Otherwise known from Isle Royale and Washtenaw County

*CRATONEURON COMMUTATUM* (Hedw.) Roth — Cedar swamp east of Gaylord, Otsego County Otherwise known only from Alger County

*HYGROAMBLYSTEGIUM IRRIGUUM* (Wils.) Loeske — Growing over stones in running brook southwest of Ionia, Ionia County Southern extension from Douglas Lake and the Upper Peninsula

\**HYPNUM MOLLUSCUM* Hedw — This is a beautiful feathery moss common along the borders of cedar-tamarack swamps and wet woods where the shade is not too dense Its soft plumelike appearance and bright yellow-green color make it very conspicuous It usually grows in large mats, little mixed with other mosses, Gratiot, Clare, and Isabella counties

*HYPNUM CUPRESSIFORME* Hedw — On rocky ledges along lake shore at Broken Rocks, Port Austin, Huron County Southern extension from the Douglas Lake region and Alger County

*AMBLYSTEGIELLA SUBTILIS* (Hedw.) Loeske — On bases and trunks of trees in shady woods, Huron, Gratiot, Newaygo, and Otsego counties Otherwise known from the Upper Peninsula and the Douglas Lake region

*PYLAISIA SELWYNII* Kindb — On trunks of trees in open woods, Mecosta, Montcalm, Gratiot, and Isabella counties. Southern extension from Glen and Douglas lakes and Ontonagon County

#### FONTINALACEAE

*DICHELYMA CAPILLACEUM* (Dill.) B. S. G. — Common on tree bases, over bushes, and old stumps in low wet river bottoms flooded at high water; Gratiot County east of Alma, and Van Buren County east of South Haven Otherwise known from Washtenaw County

*FONTINALIS LESCURI* Sull — In intermittent stream bed on tree roots and in low river bottom over roots and bushes, Gratiot County Southern extension from the Douglas Lake region.

## STUDIES IN THE GENUS AGARICUS\*

ALEXANDER H SMITH

THE genus *Agaricus* consists of a group of species characterized by purple-brown spores, free lamellae, the presence of an annulus, the absence of a volva, and the stipe, which is readily separable from the tissue of the pileus. The name "*Agaricus*" is used here in preference to "*Psalliota*" in order to comply with the International Rules of Nomenclature.

It is always very easy to recognize an *Agaricus*, but, with a few exceptions, the recognition of species is much more difficult. Owing to incomplete descriptions on the one hand and the lack of sharp, distinctive specific characters on the other the modern student of the group is faced with many difficult problems.

The characters most frequently used in classifying the species are the nature and position of the annulus, the color and nature of the surface of the pileus, the taste, odor, color, and color changes of the flesh of any part of the fruiting body, spore size and shape, and color of the immature lamellae. Within broad limits the stature of the fruiting body is also important.

The cuticle of the pileus of most species consists of radially arranged fibrils composed of fascicles of hyphae. In some species this layer remains appressed during the entire development of the fruiting body. In others the fibrils tend to become arranged into scales, which in turn may remain appressed or become somewhat recurved. At best, the difference between a scaly pileus and one which is fibrillose is purely a question of degree. Weather conditions often cause a great deal of variation, as in *A. crocodilinus* and *A. praerimosus* (23). Thus, although the character of the surface of the pileus does furnish some information of value to the taxonomist, it must be used with caution. The same is true of the color of the fibrillose surface covering. The only satisfactory approach to the problem of describing color in such a way that a reader may obtain an accurate conception of the color value expressed is the use of a color chart.

\* Papers from the University of Michigan Herbarium

The color of the young gills, particularly the presence or the absence of pink, has always been given great importance in the genus, and does furnish us with a reliable character in a broad sense. Unless pronounced, the different tones of pink or a duller flesh color are hardly of specific value, and in species in which they are usually pale it is not surprising to find occasional specimens with the pinkish color absent. *A. placomyces* is a good example.

The character of the annulus, whether it is double or single, is also used considerably. This character is reliable so far as the doubleness is concerned. If a collector finds a specimen the annulus of which has colored patches of tissue on the under side, he may be sure that it falls into the group so distinguished. If, however, the specimen has an annulus which is smooth or merely fibrillose on the under side, he is not in position to make an accurate decision. He may have a species which typically has a double ring, but in the specimens at hand the telltale patches may have been lost. A complete developmental series is necessary to establish the character of singleness. Much confusion has been caused in the group of species related to *A. silvaticus* because of the unreliability of this character.

Of the microscopic characters, spore size and shape are the most constant and valuable. Lactiferous ducts are quite common in the flesh of most of the species, and there are no sharply distinctive types of cystidia, as in the genus *Mycena*. Clavate, somewhat enlarged sterile cells are present on the gill edges in certain groups of species, but they show little difference in shape and size.

In order to study the constancy of spore size one must first have access to large numbers of collections from various localities, preferably of material identified by a single investigator. These conditions are obviously difficult to meet. Wherever I have been able to realize them, as in studying *A. subrutilescens*, *A. silvicola*, and *A. diminutivus*, I have found spore size and shape to be remarkably constant. Abnormally large spores are often observed in mounts of certain species, and as a result one might be tempted to decide that spore size is not constant. Such a conclusion would not be justified, however, since one usually finds that the supposed variation is constant for a species, as in *A. crocodilinus*.

Because of the lack of accurate information on the shape and size of the spores in American species of *Agaricus* I have brought together

in Figures 1-4 drawings of the spores from the American types, so far as they have been available

The study of the type material of species described by Atkinson, Peck, and Murrill has been made possible through the courtesy of Professor H M Fitzpatrick, of Cornell University, Ithaca, New York, Dr H D House, New York State botanist, New York State Museum, Albany, New York, and Dr Fred J Seaver, of the New York Botanical Garden I also wish to express my thanks to Dr W A Murrill, of Gainesville, Florida, and to Dr S M Zeller, of Corvallis, Oregon, for material of some of the species they have recently described The photograph of *A Pattersonae*, which was found with the type at Albany, New York, is reproduced here with the permission of Dr House, who very kindly had a copy made for that purpose I took the remaining photographs and made the collections cited by number They are deposited in the Herbarium of the University of Michigan The field work on the Pacific Coast was carried out during the seasons of 1935 and 1937, with the aid of grants from the Horace H Rackham School of Graduate Studies of the University of Michigan

All color names in quotation marks are taken from R Ridgway, *Color Standards and Color Nomenclature*, Washington, D C, 1912 The drawings were made with the aid of a camera lucida and are reproduced at a magnification of approximately 1300 times

## LIST OF SPECIES

### *AGARICUS AUGUSTUS* AND CLOSELY RELATED SPECIES

*AGARICUS AUGUSTUS* Fr (Fig 1a) — Pileus (10)18-35(45) cm broad, cylindric with a flattened apex in button stages or tending toward convex, becoming broadly convex with a flattened apex and finally plane or with a broad flattened umbo, surface dry, densely covered at all stages by long coarse fibrils which become arranged into more or less fasciculate-appressed scales toward the margin, the disc remaining evenly and densely fibrillose but often becoming areolate, color of fibrils "wood-brown" to pale cinnamon-brown, becoming darker sordid brown over the disc, the whitish to faintly yellowish ground color showing toward the margin, margin usually fringed with fibrils, flesh 1-2 cm thick (in very large fruiting bodies the flesh is thin in relation to the

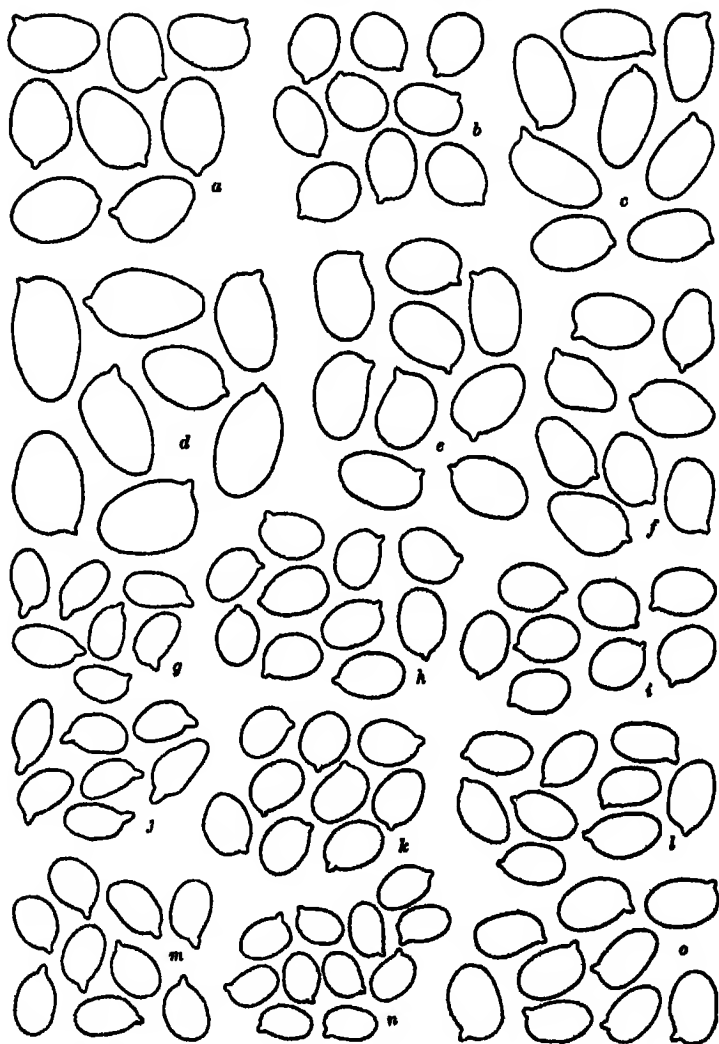


FIG 1 a, *A. augustus*, b, *A. subrugescens*, c, *A. perrarus*, d, *A. crocodilinus*, e, *A. arvensis*, f, *A. arvensis* var *palustris*, g, *A. magniceps*, h, *A. silvicola*, robust form, i, *A. silvicola*, typical form and type of *A. abruptusbulbus*, j, *A. magniceps*; k, *A. floridanus*, l, *A. albolutescens*; m, *A. albosanguineus*, n, *A. cretaceus*, o, *A. ciscoensis*

size of the cap), white but becoming slightly yellowish on the surface, no color change noticed when the fresh flesh was cut or bruised, odor slight, taste distinctly like that of almonds, lamellae white at first and remaining so until near maturity, becoming "deep brownish vinaceous" or more pinkish for a short time before becoming black, remote, narrow, moderately close, often crisped, edges even, stipe 10-12 (18) cm long, 2-6 (9) cm thick, equal, clavate or ventricose, base immersed in the soil and at times subradicate, stuffed solid, becoming hollow in age (especially at the base), whitish to very pale buff and densely fibrillose-scaly below the annulus, silky, glabrous, and whitish above, not changing color readily when handled but becoming sordid brown slowly after being bruised or when dried (not at all yellowish when dried), annulus double, median to superior, with cottony "wood-brown" patches on the under side, spores 7-10  $\times$  5-6  $\mu$ , broadly ellipsoid, dark chocolate-brown under the microscope, with a hyaline oblique apiculus

Gregarious to scattered in mixed forest of redwoods, Brookdale, California, and under spruce near Smith River, California, during the seasons of 1937 and 1938. The notes for the description given above were based upon the Smith River collection. Miss E. E. Morse, of Berkeley, very kindly sent to me the material collected at Brookdale.

The outstanding characters of this species are the colors, the stipe with its rather deeply buried base, the immense size, the almond-like taste of the raw flesh, and the spores. The color of the disc is dull brown, and was very aptly described by Fries (6) as "dilute brunneo". The conspicuous fibrillose scales are concolorous with the disc or a darker dull brown. This color difference is very distinct and readily separates *A. augustus* from the two reddish to yellowish tawny species, *A. perrarius* and *A. subrufescens*, neither of which has a stipe base which penetrates into the soil. The color of the flesh beneath the scales on the pileus of *A. augustus* is whitish at first, but may soon be tinged dull lemon-yellow. Fries's illustration (7) shows the color of the scales almost exactly as I found them in my collection. In age or when bruised the stipe slowly becomes "army-brown," in contrast with the "warm buff" color of the bulb and the surrounding mycelium of *A. perrarius*. Fries (6) described the stipe of *A. augustus* as



glabrous, but floccose just below the annulus and unpolished. This indicates that the stipe was peronate up to the annulus, but that the sheath did not readily tear into scales. The stipes of the California collections had such a sheath, but in them it broke up into fibrillose patches. I have observed specimens of *A. perrarus* with a smooth untorn sheath as well as some with the sheath torn into scales, and as a result I am not inclined to consider significant this apparent discrepancy between Fries's description of *A. augustus* and my specimens. The gills in my specimens, although remaining white during most of their development, did exhibit pinkish to pinkish brown tints for a short time. This is not in accordance with Fries's descriptions. From my observations on *A. perrarus* and other species, however, I am sure that the presence or the absence of pink in young gills of species of *Agaricus* is not an infallible character, and that a certain amount of variation can reasonably be allowed. In addition to the slight difference in gill color the stipes of my specimens showed a greater tendency to become hollow than is indicated by Fries. Here again the difference seems to be slight and within the limits of expected variation.

Under the name *A. villaticus* Brond, Hotson and Stuntz (9) report from Washington specimens which are apparently this species. In the specimens they found, the color changes were more pronounced than in mine. This is a variation which is to be expected. Schaffer and Moller (22) have given a detailed account of *A. vaporarius*, under which they list *A. villaticus* Brond as a synonym and state that it has subglobose spores along with other characters which readily distinguish it from the Washington specimens. An illustrated specimen which Hotson and Stuntz (9) identified as *A. perrarus* is also strongly suggestive of *A. augustus*, and should be placed there in spite of the apparent differences in annulus and length of stipe which these authors point out. In my concept of *A. augustus* I have adhered to the most nearly complete of the Friesian (6) descriptions. It is obvious that the species has been variously interpreted by European investigators. Ricken (21) has placed here a species very similar to *A. crocodinus* of the *A. arvensis* group. Konrad (12) has apparently followed Maire (16) in placing *A. perrarus* Schulz under *A. augustus*. Rea (19) considered *Psalliota villatica sensu* Bresadola

to be identical with *A. augustus* Bresadola's (3) illustration of *P. villatica* strongly suggests, however, a relationship with *A. crocodilinus* Schäffer and Möller (22), who apparently have retained the Friesian concept of *A. augustus*, have pointed out the possibility of confusing *A. vaporarius* with it. Unfortunately they did not publish a detailed account of the former plant. Lange (15) recently published a good illustration of *A. augustus*. The color of the young gills as he has pictured it is very similar to the pale grayish vinaceous shades I have observed in young specimens. For additional comments see *A. perrarius*.

**AGARICUS PERRARUS** Schulzer (Fig. 1c) — Pileus 8–15 cm broad, convex or obtuse, becoming more or less expanded, finally nearly flat, surface dry, innately fibrillose at first, in age spotted by appressed-fibrillose scales or the fibrils merely loosely arranged in fascicles, disc remaining innately fibrillose, color of fibrillose scales and the disc "ochraceous tawny," the ground color "cinnamon-buff" or more yellowish, margin often fibrillose-appendiculate with yellowish fibrils; flesh soft, white, moderately thin (8–15 mm), odor faintly pungent, taste strong and resembling bitter almonds, lamellae crowded, rather remote, whitish to grayish pink when young, slowly becoming dull chocolate-brown, edges pallid to yellowish and slightly uneven, stipe 8–15 cm long, 10–15 mm thick, equal above an abrupt bulb which is flattened below, stuffed solid with a white silky pith, hollow in age, peronate with a white fibrillose sheath below the annulus, the sheath either remaining smooth or becoming torn into white fibrillose patches which become yellowish in age or if bruised, whitish and silky above the superior annulus, annulus buffy white and silky above, the under side colored like the pileus and torn into floccose patches, spores 8–10 (12)  $\times$  4–5 (6)  $\mu$ , ellipsoid, dull grayish brown under the microscope, dull chocolate-brown in mass.

I have found this to be a rather abundant species in northern California (3637, 3699, 8215, 8185, 9475). It prefers conifer habitats there, and seems to be most frequent along or near the edges of dense second-growth stands of spruce. I have collected it under pine in Oregon (8161). The spores illustrated were taken from a fruiting body of collection 8161, from Lincoln County, Oregon, October 28, 1937.

Zeller (25) has reported this species under the name *A. augustus*.

Larger spores, as indicated by the measurements in parentheses in the description on page 113, are occasionally found in mounts, but not in sufficient numbers to warrant being included in the typical size range for the species. In many of my specimens the lamellae were by no means pure white at first, those that were soon became tinged with grayish pink. They were never found to be so bright a pink as they are in *A. subrufescens*, however. *A. perrarus* has been placed in synonymy with *A. augustus* by some, but is very distinct. The abrupt bulb, or at least the flattened base of the stipe, is a constant feature, and the yellow to ochraceous tawny colors are equally distinctive, especially in dried specimens. The gill colors of *A. augustus* and *A. perrarus* are apparently about the same, sometimes without any pink (see Zeller's comments) and sometimes faintly flushed grayish pink (my own observations, also on Oregon specimens). Because of the differences in gill color which I have observed in *A. perrarus*, I hesitate to use the character as one of more than secondary importance. Lange (14) first recognized *A. perrarus*, but described its spores as  $7.5 \times 5-5.5 \mu$ . Later (15) he adopted the name *A. subrufescens*, but retained the concept that one was a synonym of the other. I have had the opportunity to examine ample material of both, and have found the difference in spore size to be constant. This difference is correlated with others of less importance, such as pinker gills and reddish brown colors of the pileus in *A. subrufescens*. I have used Bresadola's interpretation of *A. perrarus* here because it is the most authentic account available. It is evident from the literature that Schulzer was in close touch with Bresadola, who was thus in a more favorable position than anyone else to evaluate Schulzer's specimens. The illustration of *A. perrarus* published by Hotson and Stuntz (9) shows the typical stipe base of *A. augustus*, but they describe the stipe of the former plant as equal and the base as bulbous.

**AGARICUS SUBRUFESCENS** Pk. (Fig. 1b) — I have collected this fungus in Michigan and compared the specimens with Peck's type, but cannot add any information to that found in Kauffman's account (10). It has been reported from Oregon by Zeller (25) and from Washington by Hotson and Stuntz (9). Owing to a marked discrepancy in spore size in the report of the Washington specimens, it is clear that a different species is repre-

sented If *A. subrufescens* occurs in Europe it has probably been known under the name *A. peronatus* Massee, which is described as having spores  $6 \times 4 \mu$ . Until more critical studies of the English species have been made and the spore measurements are verified, it does not seem advisable to adopt the latter name. The drawings of the spores in Figure 1b were made from type material.

#### AGARICUS ARVENSIS AND CLOSELY RELATED SPECIES

**AGARICUS CROCODILINUS** Murrill (Fig 1d, Pls I-II) — Pileus 10–35 cm broad, convex, remaining broadly convex, surface dry, fibrillose, the fibrils soon becoming arranged in fascicles or appressed scales, as expansion takes place the scales recurve somewhat, finally the flesh becomes deeply cracked into a series of overlapping scales which in extreme cases (usually on fruiting bodies exposed to the sun) are 1–2 cm long, sometimes the surface remains merely appressed-fibrillose and smooth (usually on fruiting bodies in shady places), color white or tinged “cinnamon-buff” over the disc, the tips of the scales frequently tinged brownish (near “avellaneous”), no yellow color noted at any stage either when wet or dry, flesh very thick (up to 3 cm), firm, white, unchanging, odor and taste not distinctive or the latter slightly bitter upon continued chewing, lamellae broad, touching the stipe at first, at times becoming remote in age, close, many-forked near the base, “light russet-vinaceous” in small closed buttons, dull chocolate-brown at maturity, not truly pink at any stage, stipe (7) 10–15 cm long, 2–4 (7) cm thick, subfusiform to clavate with a narrowed base, stuffed solid, becoming hollow, white and unchanging when bruised, becoming sordid reddish brown above in age, base at first with concentric rows of scales left by the universal veil tissue, glabrous and silky above, annulus superior, double, sometimes leaving two distinct rings on the stipe, the lower one more or less frayed or cracked, sometimes the lower ring adheres to the under side of the upper ring and forms large “cinnamon-buff” areolate patches; basidia four-spored, spores (7)  $8-11 \times 5.5-7 \mu$ , in many piles comparatively large numbers of spores  $12-16 \times 7-8 \mu$  are found, cheilocystidia,  $42-50 \times 7-12 \mu$ , form a sterile band on the margins of the gills; lactiferous hyphae are present in the pileus and gill trama.

Growing singly to scattered in pastures, meadow lands, or on waste ground. I have not been able to locate the type of this species, and so have used for the drawings spores from collection 8462. The fruiting bodies shown on Plates I-II, which are from the same collection, are of young specimens. Zeller (26) has reported the species from Oregon, and it is not uncommon in northern California. The description and the photographs are given here in order to facilitate a critical comparison of Murrill's species with European species of the *A. arvensis* group. *A. Bernardi* is apparently very close to it, but is described as having an annulus which soon disappears and flesh which finally is stained reddish brown. Lange (14), who collected a closely related species, used for it the name *Psalliota villatica* Brond. He points out that *A. augustus* (*Psalliota*) *sensu* Ricken (21) and *Psalliota leptotoides* may be the same as his *Psalliota villatica*. All of these are very similar to *A. crocodilinus*. Schäffer and Moller (22) have recently discussed a closely related series of forms, and have given the name *Psalliota arvensis* subsp. *macrospora* to one of them. Apparently all accounts of these European species differ in minor characters from *A. crocodilinus*.

**AGARICUS ARVENSIS** Fr (Fig 1e) — Pileus 4–15 cm broad, convex to subplane, buttons ovoid to subcylindric, surface dry, innately white-fibrillose, the fibrils sometimes converging to form appressed scales, with a narrow sterile margin frequently decorated with veil remnants, color white or tinged creamy to yellowish on the disc, flesh up to 1 cm thick, firm, white, staining yellow near the cuticle when bruised, odor none, taste mild or very slightly of almonds, lamellae remote, rather broad (8–12 mm), close, nearly equal, white or faintly grayish at first, slowly changing to dull vinaceous brown with a pinkish tint, finally dark blackish brown (typically “avellaneous” in late stages of immaturity); stipe 6–12 cm long, 1–2 cm thick, equal above a slightly clavate base, stuffed, becoming hollow, white, changing to yellowish in age, glabrous and silky above and below the superior annulus, annulus double, smooth and silky on upper side, with areolate cottony patches beneath, white or tinged yellowish with age; basidia four-spored; spores 7–9 (10)  $\times$  5–6  $\mu$ , ellipsoid, fuscous brown under the microscope.

Gregarious on dung and sod in or along the edges of pastures.

The spores figured are from collection 9066, which was found near Smith River, California, in 1937. After an examination of the spores of various collections determined as *A. arvensis* by American investigators it became apparent that two species have been included under this name in North America. One is characterized by spores which measure  $5-6.5 \times 4-5 \mu$ , and the other by spores as given in the foregoing description. I have examined collections of the latter from New York, Michigan, Ohio, and California, and believe that it is the species which should bear the name *A. arvensis*. Nearly all Kauffman's collections are of the small-spored species. For additional comments upon it see *A. silvicola*.

**AGARICUS ARVENSIS** var. **palustris**, var. nov. (Fig. 1f) — Pileus 10-35 cm latus, convexus demum late umbonatus, siccus, fibrillosus, nitens, demum subsquamulosus, albidus, caro 1-2 cm crassa, albida, demum luteo-maculosa, cum odore amygdalino et sapore, lamellae latae (1-1.5 cm), confertae, albae demum brunneo-fuscae, stipes 10-30 cm longus, 2-3 cm crassus, clavatus, albidus demum luteo-maculosus, sericeus, annulus pendulus, amplus, duplicatus, exterior revolutus, radiatum fissus, sporae  $7-8.5(9) \times 4.5-5 \mu$  — Specimen typicum legit A. H. Smith n. 7546 prope Kent Lake, Oakland Co., Mich., Sept. 13, 1937, in Herb. Univ. Mich. conservatum.

Pileus 10-35 cm broad, broadly ovoid to convex when young, becoming broadly umbonate, convex or plane, surface dry, appressed silky-fibrillose, shining in age, becoming minutely fibrillose-scaly around the disc, white or shining white, disc often creamy or yellowish, the fibrillose scales sometimes become brownish, flesh thick (1-2 cm  $\pm$ ), firm, coarse, white, staining slightly yellowish when bruised, especially when moist, odor and taste strong, resembling that of almonds; lamellae broad (1-1.5 cm), close, remote from the stipe, white, remaining so until near maturity, becoming brownish then pale to dark fuscous brown, edges even, stipe 10-30 cm long, 2-3 cm thick, equal above a massive clavate bulbous base (4-5 cm thick), stuffed, becoming hollow, white, staining yellowish when handled, silky and shining above the median to superior annulus, appressed-fibrillose with innate fibrils below, not sheathed, annulus flaring, ample, membranous, double, striate and silky above, lower layer cracked

into irregular yellowish cottony-fibrillose patches; cheilocystidia in large clusters or forming a sterile band on the edge of the gill,  $18-28 \times 8-15 \mu$ , clavate, yellow when revived in KOH, basidia four-spored, spores  $7-8.5(9) \times 4.5-5 \mu$ , usually ovoid, dark fuscous under the microscope, with an inconspicuous oblique, hyaline apiculus, lactiferous hyphae in cap and gill trama hyaline, contorted and highly refractive

Gregarious on low swampy ground under elm, ash, and red maple. Hitherto the variety has been found only in the vicinity of South Lyons and Kent Lake, Oakland County, Michigan; it seems to fruit during rather dry seasons

The figures of the spores were drawn from type material. They are practically of the same size as spores of *A. arvensis*, but the difference in shape is conspicuous when mounts of both are compared under the microscope. A small number of ellipsoid spores are nearly always found in mounts of the variety, a circumstance that indicates its relationship to *A. arvensis* rather than to *A. silvicola*. The strong odor of almonds, the habitat, and the difference in the shape of the spores all distinguish it from the former species

**AGARICUS SILVICOLA** (Vitt.) Sacc (Fig 1 h-i) — *Agaricus abruptibulbus* has been correctly referred as a synonym of *A. silvicola*. The spores shown in Figure 1i, are from the type of *A. abruptibulbus* and measure  $5.5-6.5 \times 4-4.5 \mu$ . In the numerous collections I have examined the spore size has been found to be a remarkably constant character, and one which serves better than any other to distinguish the species from *A. arvensis*. In North America, and very likely in Europe also (see Schäffer and Möller, 22), a robust form occurs which has been frequently mistaken for *A. arvensis*. Kauffman's account (10) of the latter is of such a form, and Peck also had placed it in *A. arvensis*. The spores illustrated in Figure 1h, which are taken from one of Kauffman's collections determined as *A. arvensis*, illustrate their similarity to those of *A. silvicola*. For a comparison of the macroscopic characters of the two forms see Kauffman's description of *Psalliota arvensis* and *P. abruptibulba*.

**AGARICUS MAGNICEPS** Pk (Fig 1 g, j). — Pileus 5-12 cm broad, convex, becoming plane, surface dry, appressed-fibrillose, the fibrillose layer frequently breaking up into minute patchlike

appressed scales, in age becoming areolate around the disc, entirely white or creamy white, the disc occasionally somewhat avelaneous, the scales more or less pale crust-brown in age; flesh moderately thick, white, not changing to yellow when bruised or in drying (plants collected in dry weather), odor and taste slight, somewhat nutty, lamellae close, broad, remote, white, slowly changing to grayish vinaceous and finally dull reddish brown, edges even, stipe 7-10 cm long, 1-2.3 cm thick, with a clavate to subbulbous base 3-4 cm thick, stuffed, becoming hollow, white, silky and shining above, more or less cottony fibrillose below the median annulus, not sheathed, annulus white, smooth and silky above, fibrillose beneath, with thick cottony white patches on the under side near the margin, basidia four-spored, spores 6-7.5 (8)  $\times$  3-3.5 (4)  $\mu$ , narrowly ellipsoid to subovoid, with a very prominent obtuse hyaline apiculus, pale reddish brown under the microscope

Spores of the type are illustrated in Figure 1g. They are rare, appear immature, and measure 5-6  $\times$  3-3.5  $\mu$ . The fruiting bodies in the type collection are very poorly preserved. In the single collection from Michigan, from which the description was drawn, the spores were slightly larger but of the same shape (Fig. 1j). The pronounced apiculus and the pale reddish brown color are their outstanding characters. No color change to yellow was noted on the Michigan collection, but parts of the type have dried pale yellowish, a fact which, in addition to the pale colors and its resemblance to *A. arvensis* in stature, places the species in this group.

**AGARICUS FLORIDANUS** Pk (Fig. 1k) — The spores measure 5-6  $\times$  4-4.5  $\mu$  and appear nearly black under the microscope. In the only specimen with a well-preserved annulus the latter was found to have two distinct marginal limbs. It is difficult to determine from this whether the ring is truly double or single. Because of the resemblance of the fruiting bodies to robust forms of *A. silvicola* I place the species here provisionally.

**AGARICUS ALBOLUTESCENS** Zeller (Fig. 1l) — The spores were drawn from type material which Dr. Zeller sent to me for that purpose. They measured (5) 6-6.5 (7)  $\times$  3.5-4  $\mu$ . During the fall of 1937 I collected this species in northern California. The viscosity mentioned in the original description is more apparent



than real. In other words, it is not due to a typical gelatinous layer of hyphae, and a true pellicle is not present. The stickiness is due to the rather slight gelatinization of the surface fibrils which normally cover the pilei of species in this genus. I have observed a similar viscosity or pseudoviscosity on species of *Inocybe* and in *Inoloma*, a subgenus of *Cortinarius*. Apparently the effect is produced by prolonged wet weather. *A. albolutescens* is most closely related to robust forms of *A. silnicola*.

**AGARICUS CRETACELLUS** Atk (Fig 1n) — Pileus 4–7.5 cm broad, ovoid to convex, with a somewhat flattened disc, becoming plane or slightly umbonate, thin, smooth, subviscid when moist but no gelatinous pellicle present, surface of appressed silky fibrils which may converge to form inconspicuous appressed scales, margin silky and at times decorated by fragments of the veil, pure white, only occasionally staining slightly yellowish, in age sometimes pinkish near the margin as gill colors show through the flesh, flesh whitish or tinged pinkish near the lamellae, odor faintly pungent, taste mild or slightly amygdaline, lamellae narrow, 3–4 mm, narrowed behind, equal, approximate to the stipe at first but becoming remote in age, crowded, white when young, slowly changing to “pale vinaceous fawn” and finally “army-brown,” never becoming black, edges even, stipe 8–10 cm long, 6–10 mm thick, clavate to bulbous, tapering slightly toward the apex, stuffed with a silky somewhat indistinct pith, white and smooth above the annulus, white and minutely floccose to subscaly below, not staining yellow, annulus superior, with cottony areolate patches on the under side, silky and smooth above, white, spores 5–5.5 × 3–3.5  $\mu$ , ellipsoid, pale chocolate-brown under the microscope; basidia four-spored, cheilocystidia not differentiated.

Gregarious on leaf mold in mixed forests. The description was drawn from specimens collected at Cades Cove, Tennessee, during the summer of 1937. The species is readily distinguished by its small spores and dull brown gills. The resemblance to *Lepiota naucina* is rather striking, but the spore color distinguishes it at once.

**AGARICUS ALBOSANGUINEUS** Hotson & Stuntz (Fig 1m) — The spores were drawn from material sent to me by Professor Hotson. This species has been described as having a single annulus, but, to

judge from the original description, the authors did not have enough material of all stages to enable them to study variation. In *A. silvicola*, to which *A. albosanguineus* is very closely related, the double annulus is not always discernible, and in the *A. silvaticus* group in general I have found it to be very unreliable. Hence I am inclined to disregard this character in comparing their species with those described from Europe. As Hotson and Stuntz have pointed out, *A. exsertus* Viv. *sensu* Rea (19, p. 88) does not agree in its characters with their species. However, *Psalliota Benesi* Pilat seems to be very similar to *A. albosanguineus*, and I seriously doubt whether the latter can be maintained as a species. Pilat's Latin description is translated here in order that American investigators who do not have access to the original may compare the accounts of both species.

*Psalliota Benesi* Pilat — Pileus white, fleshy, dry, at first subglobose, next hemispheric-campanulate, later explanate, 6–15 cm in diameter, at first glabrous, smooth, then somewhat squamulose; stipe white, very long (regularly 16 cm), often twice as long as the pileus is broad, cylindric, base somewhat incrassate, solid at first, becoming hollow, more or less flexuous, lower portion slightly floccose-squamulose, above the annulus as well as the upper surface of the annulus thinly fibrillose. Annulus large, double, dentate on under side. Flesh white, blood-red when bruised, then fuscous. Spores ovato-ellipsoid,  $5.5 \times 3.5$ – $4 \mu$ , badious, with a thick wall, uniguttulate. Basidia clavate, hyaline, with a thin wall, with four sterigmata,  $18$ – $25 \times 6$ – $8 \mu$ . Sterigmata narrow,  $2 \mu$  long. Context of lamellae (central portion) of thin-walled, hyaline smooth hyphae  $4$ – $5 \mu$  in diameter.

#### AGARICUS SILVATICUS AND CLOSELY RELATED SPECIES

*AGARICUS SUBRUTILESCENS* (Kauff.) Hotson & Stuntz (Fig. 2c, Pl. III) — The drawings of the spores were made from the type. Spores of twenty-one collections of this species have been examined, and they have been found to be remarkably constant in size. The range for the entire number of collections was  $(4.5) 5$ – $6 \times 3$ – $3.5 \mu$ . The species is common in the Cascade Mountains of Oregon and along the coast of northern California. It is readily distinguished by the dark vinaceous brown fibrils of the pileus and the white fibrillose patches or scales below the annulus on

the stipe In many of my specimens the annulus was typically "single," but in the majority it was "double," as in *A. silvicola* In many, also, the veil remnants which usually form the patches on the under side of the ring were aggregated along the margin They caused it to appear quite thick and made it difficult to decide in which of the two categories the ring should be classed To judge from my observations on this species, *A. silvaticus*, and *A. glaber*, the situation is by no means rare, and hence in this group it is impossible to use the character to advantage taxonomically

**AGARICUS GLABER** Zeller (Fig 2b, Pls IV-V) — The drawings were made from type material The very pale colors of the pileus in young stages distinguish it from *A. silvaticus*, to which it is closely related Very old specimens can be readily distinguished by their glabrous dark brown pilei

**AGARICUS SILVATICUS** Fr (Fig 2a; Pls VI-VII) — Pileus 4-10 (12) cm broad, broadly convex, becoming plane, dry, surface covered by a fibrillose cuticle when young, cuticle "russet," as expansion takes place the fibrils of the cuticle become aggregated into appressed scales near the margin, at maturity the disc remains russet or darker and the scales become "tawny" or paler with the white ground color showing between them, in age the scales tend to become "pecan brown" or more reddish, flesh moderately thick and firm, rather moist, whitish or pallid, slowly becoming reddish brown, odor none, taste slightly amygdaline, lamellae crowded, narrow to moderately broad, edges even, "light grayish vinaceous" before the veil breaks, "brownish vinaceous" near maturity, finally becoming "army-brown" or darker, stipe 6-11 cm long, 1-2 cm. thick, tapering slightly above a subbulbous base, hollow, appressed-silky above and below the superior annulus, whitish but becoming tinged pinkish brown, annulus whitish with vinaceous-tinged floccose scales or patches on the under side, sometimes merely white-fibrillose below, spores  $5-6 \times 3-3.5$  (4)  $\mu$ , broadly ellipsoid, fuscous brown under the microscope, dull chocolate-brown in mass

This species is found sporadically, but often abundantly, under Douglas fir and other conifers in Washington, Oregon, and California The spores for the illustration were drawn from a specimen collected by Lars Romell in Sweden and deposited at the

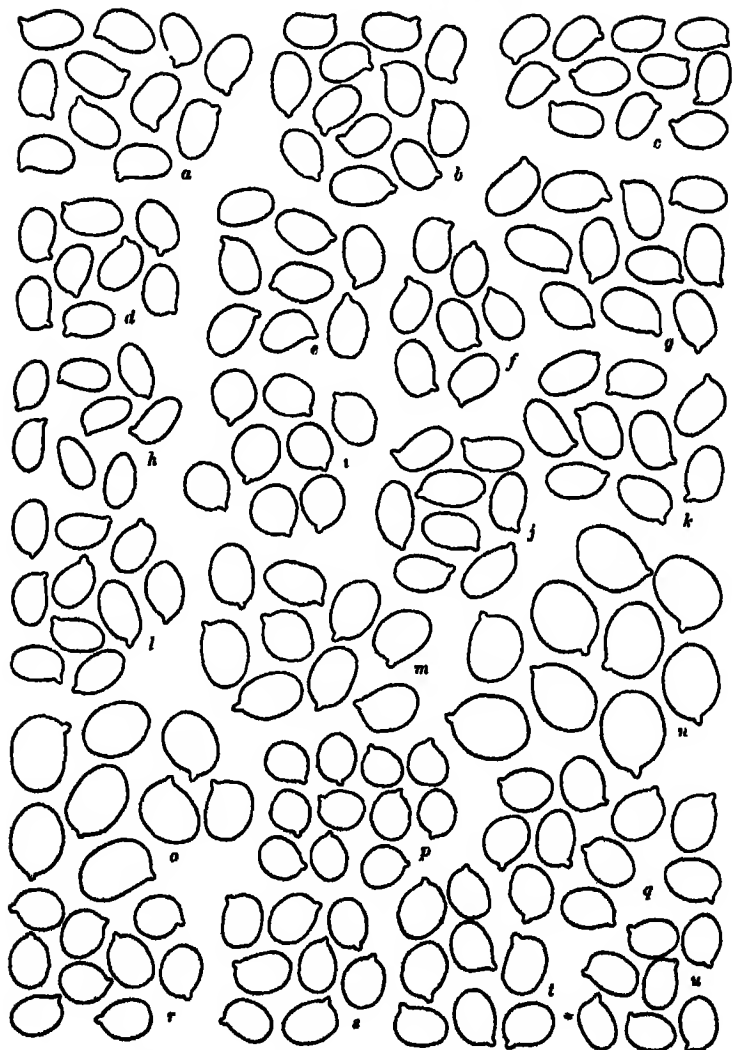


FIG 2. a, *A. silvaticus*, b, *A. glaber*, c, *A. subrufolescens*; d, *A. rubribrunneus*, e, *A. placomyces*, f, *A. meleagris*, g, *A. haemorrhoidarius*, h, *A. placomyces* var. *microsporus*, i, *A. Kaufmanni*, j, *A. approximans*, k, *A. sludens*, l, *A. pocillator*, m, *A. lilaceps*, n, *A. halophilus*, o, *A. brunneus*, p, *A. comptulus*, q, *A. comptuloides*, r, *A. comptuliformis*, s, *A. auricolor*, t, *A. micromegathus*, u, *A. diminutivus*

New York Botanical Garden, New York City. My collections, 2837 from Washington, 8031 from Oregon, and 9404 from California, appear to be identical with Romell's specimen. Here even more than in *A. subrutilescens* the single or the double character of the annulus is unreliable. In groups of twenty-five to fifty individuals one is often able to select in almost equal numbers specimens with double rings, with single rings, or with rings having a double margin. There is no readily discernible color change to red in either the scales or the flesh of the pileus. The change takes place slowly as the fruiting bodies pass maturity or remain overnight in a laboratory.

**AGARICUS HAEMORRHODARIUS** Schulz in Kalch (Fig. 2g, Pl. VIII)

— The spores drawn were taken from collection 5037, found in a low maple-elm swamp near South Lyons, Michigan. Kalchbrenner's figure illustrates the stature of the Michigan collection very well. The color change in this species is pronounced and <sup>to</sup> apparently reliable. It is in decided contrast to that of *A. silvaticus*. The colors of these two are very similar when dried. When fresh those of *A. silvaticus* are more tawny brown to russet, whereas those of *A. haemorrhodarius* are vinaceous brown to grayish vinaceous toward the margin. The gill edges of 5037 were covered by sterile clavate cells  $28-35 \times 8-11 \mu$ . This species has been variously interpreted. A large-spored species is referred here by some (Lange, 14), and such a one was also found among Kauffman's collections. Unfortunately, the material was sent to Kauffman without complete notes. The dried specimens and spores both indicate a relationship to *A. brunnescens*. Kauffman placed in *A. haemorrhodarius* the small-spored form with the stature of *A. silvaticus*, and I have adhered to this concept. Most of the fruiting bodies in the collection cited above were young, but no yellowish stains developed when any part was bruised. The color change to blood-red was almost instantaneous in my collection. Peck (18) describes the color change of the flesh as slow, and his illustration shows fruiting bodies much grayer than mine. Peck's description and illustration are very suggestive of some forms of *A. placomyces*, but such a relationship has not yet been established.

**AGARICUS RUBRIBRUNNESCENS** Murr (Fig. 2d) — The spores of the type measure  $5-5.5 \times 3-3.5 \mu$ . I have not studied fresh speci-

mens The gill edges are furnished with scattered clavate to subcapitate cheilocystidia,  $30-70 \times 10-14 \mu$  Murrill (17) stated that this plant differed from *A. haemorrhoidarius* in having smaller spores and a conspicuously scaly pileus As it is shown in Plate VIII and as it is usually described by European investigators, the latter species does have a decidedly scaly pileus A comparison of *d* and *g* in Figure 2 does not show any significant difference in spore size My measurements of the spores of *A. haemorrhoidarius* are  $5-6.5 \times 3.5-4 \mu$  A difference which Murrill did not mention, but which is apparent from his description, is that the color change in *A. rubr Brunnescens* is slower and not so bright as that in *A. haemorrhoidarius* This difference indicates that Murrill's species is closer to *A. silvaticus* I believe it should be referred to the latter as a synonym The color change is apparently slightly more pronounced than in the western collections referred to *A. silvaticus*, but evidently the difference is no greater than that frequently encountered in *A. placomyces*

**AGARICUS PLACOMYCES** Pk (Fig. 2e, Pl IX) — The spores of the type measure  $4.5-5.5 \times 3.5-4 \mu$  In the fifteen collections which I have examined they are exactly as in the type Spores of *A. meleagris* J. Schaeffer are illustrated in Figure 2f for comparison There are no appreciable differences I believe that these two species are the same *A. placomyces* is rather variable, in some collections the pink color of the gills is very pronounced, in others it is very faint The very young gills may be either white or grayish At times the flesh may become decidedly pinkish or even exhibit a slight color change when bruised, but as yet I have not been able to correlate these differences with any other characters, and I regard them as mere variations Schaeffer wrote to Kauffman concerning *A. meleagris*, which Kauffman believed was distinct In going over Kauffman's notes I found that at that time he was regarding several of his Olympic Mountain collections as a new species, closely related to *A. placomyces*, and it is possible that he considered *A. meleagris* to be identical with them I have collected the Olympic Mountain form in great abundance in the vicinity of Lake Crescent, Washington, and I believe it is merely a growth form of Peck's species

**AGARICUS PLACOMYCES** var. **microsporus** var. nov (Fig. 2h) — Pileus 3-5 cm. latus, convexus, fuligineo-fibrillosus, in centro fuscus,

caro alba, fracta subrosea, inodora, sapore miti, lamellae pallidae, demum incarnatae, stipes 5-7 cm longus, 6-8 mm crassus, bulbosus, annulus amplus, duplicatus, sporae  $4-5 \times 2.5-3 \mu$  — Specimen typicum legit A H Smith n 8800 prope Smith River, Calif, Nov 16, 1937, in Herb Univ Mich conservatum

Pileus 3-5 cm broad, convex, surface covered by dark gray innate fibrils on a white background, disc blackish, tending to become appressed-fibrillose-scaly near the margin; flesh white, quickly staining reddish when bruised, odor and taste not distinctive; lamellae pallid, becoming pinkish and finally dark fuscous brown, stipe 5-7 cm long, 6-8 mm thick, equal above an abrupt flattened bulb, white and silky when young, turning red when bruised and in age sordid brown, annulus ample, pendulous, double, with fuscous areolate patches on the under side near the margin, spores  $4-5 \times 2.5-3 \mu$ , narrowly ellipsoid, fuscous brown under the microscope; basidia four-spored

Scattered under spruce in northern California The two collections which were made were found to be constant in the characters described The variety is smaller than the species in nearly all its dimensions, and the color change is more pronounced than usual *A placomyces* often shows a decided tendency to develop pinkish hues in the flesh of the pileus and in the apex of the stipe, but usually does not change color readily when bruised

**Agaricus Kauffmanii**, sp nov (Fig 2i) — Pileus 5-7 cm latus, obtusus demum subexplanatus, sordide luteo-brunneus, fibrillosus; caro alba, odor subaromaticus, sapor mitis, lamellae albae, demum incarnatae, confertae, angustae, stipes 6-9 cm longus, 5-8 (10) mm crassus, bulbosus, albidus, glaber; annulus superus, albidus, membranaceus, sporae  $4.5-5.5 \times 4.5 \pm \mu$ . — Specimen typicum legit C H Kauffman prope Tahoma Park, Md, July 22, 1919, in Herb Univ. Mich conservatum.

Pileus 5-7 cm broad, at first obtusely ovoid or bullate, then subexpanded or discoid, when young entirely "tawny olive" to "Saccardo's umber," owing to a more or less continuous fibrillose cuticle, becoming appressed-fibrillose-scaly as the pileus expands, the scales "tawny olive," margin not striate; flesh white, unchanging, thin on the margin, somewhat thicker elsewhere, odor when crushed slightly aromatic, taste none; lamellae white in

button stages, becoming "pale Congo pink," pink color persisting a long time, finally becoming chocolate-brown, very crowded, narrow (4 mm  $\pm$ ), equal, free, occasionally forked at the base, thin, edge entire; stipe 6-9 cm long, rather slender, 5-8 (10) mm thick, equal above the small rounded obscure bulb, white, glabrous, stuffed with a firm white pith, apex naked; annulus superior, not broad, single, white, pendant, fragile, evanescent, very slightly floccose below; spores 4.5-5.5  $\times$  4.5  $\pm$   $\mu$ , very broadly ellipsoid to subglobose, basidia four-spored

Kauffman found the specimens growing in a grassy area near a sidewalk. The species has the stature of slender specimens of *A. placomyces*, but it is readily distinguished by its almost globose spores. The yellowish brown colors are also distinctive. The annulus was apparently single in Kauffman's collection, but I am not inclined to place much emphasis on that character. Since the dried specimens show no signs of the ochraceous tint assumed by members of the *A. diminutivus* group, they cannot logically be placed there, even though the spores are suggestive.

**AGARICUS APPROXIMANS** Pk (Fig 2j) — The spores illustrated were taken from the type. This species, which was collected in company with *A. placomyces* by E. B. Sterling, is, in my estimation, merely an aberrant form of it with an umbonate pileus and with the pink color lacking in the gills. The spores and the colors of the pilei of the two are identical. During seasons when *A. placomyces* is very abundant, as it was around Ann Arbor in 1936 (coll. 4931), large patches of fruiting bodies are often found, some of which contain individuals with little or no pink color in either flesh or gills but which could not otherwise be distinguished from typical material.

**AGARICUS ELUDENS** Pk (Fig 2k) — The spores illustrated were taken from the type and measured 5-6  $\times$  3.5-4  $\mu$ . Peck gave the measurements of the spores as 5-7  $\times$  4-5  $\mu$ , and Murrill (17) apparently copied them. Peck's figures are very suggestive of *A. haemorrhoidarius*, as is his description also. In my notes on the type I described it as similar to *A. silvaticus* in color, but slightly smaller in stature. The spores, the color of the pileus, and the changing flesh seem to me to be sufficient reason for reducing *A. eludens* to synonymy with *A. haemorrhoidarius*. The stature is suggestive of *A. sanguinarius* Karst., but in Peck's



description no mention is made of the stipe of young specimens becoming yellowish when bruised. In their accounts of *A. sanguinarius* Lange (15) and Rea (20) both note this character.

**AGARICUS POCILLATOR** Murr (Fig 2l) — The illustration was made from spores of type material sent to me by Murrill. The specimen was immature, and few dark-colored spores could be found. They measured  $4.5-5.5 \times 3-3.5 \mu$ , the basidia were four-spored. To judge from the specimen I have examined, the species is one of the forms of *A. placomyces*.

#### AGARICUS BRUNNESCENS AND CLOSELY RELATED SPECIES

**AGARICUS HALOPHILUS** Pk (Fig 2n) — The spores of the type measure  $6-7 (8) \times 5-6 \mu$ . The dried specimens resemble dried material of *A. Rodmani* in stature and color, but the delicate annulus places it next to *A. campestris*. Aside from the changing flesh, it in no way resembles species of the *A. silvaticus* group; it differs from *A. haemorrhoidarius* in its larger spores, disagreeable odor, squatty stature, and pale color when dried. It is doubtful whether the report of this species from Washington by Hotson and Stuntz is correct. They (9) describe the pileus as having broad, appressed brown scales, odor and taste not marked, and the annulus as pendant, thick, persistent, and feltlike. All these characters indicate that the Washington collection is closer to *A. vaporarius* Vitt *sensu* Schäffer & Moeller (22).

**AGARICUS BRUNNESCENS** Pk (Fig 2o) — The spores of the type measure  $6-7 (8) \times 5-6 \mu$ . Stewart (24) reported on the growth of a species, from spawn, which Kauffman determined as being very near *A. brunnescens*. Stewart's specimens are preserved in the University of Michigan Herbarium. The dried fruiting bodies as well as his description of them indicate that the species is more properly classified as *A. vaporarius*. The dark reddish brown conspicuously scaly pileus, peronate stipe, double, thick, felty annulus, the flesh, which changes to reddish when cut or bruised, and the spores all support this conclusion. Schäffer and Möller (22) comment on forms of the species in culture in Berlin, and Krieger (13) has noted that *Psalliota villatica* (a synonym of *A. vaporarius*) is grown by at least one producer in the United States. It is apparent from Schäffer's comments that the species

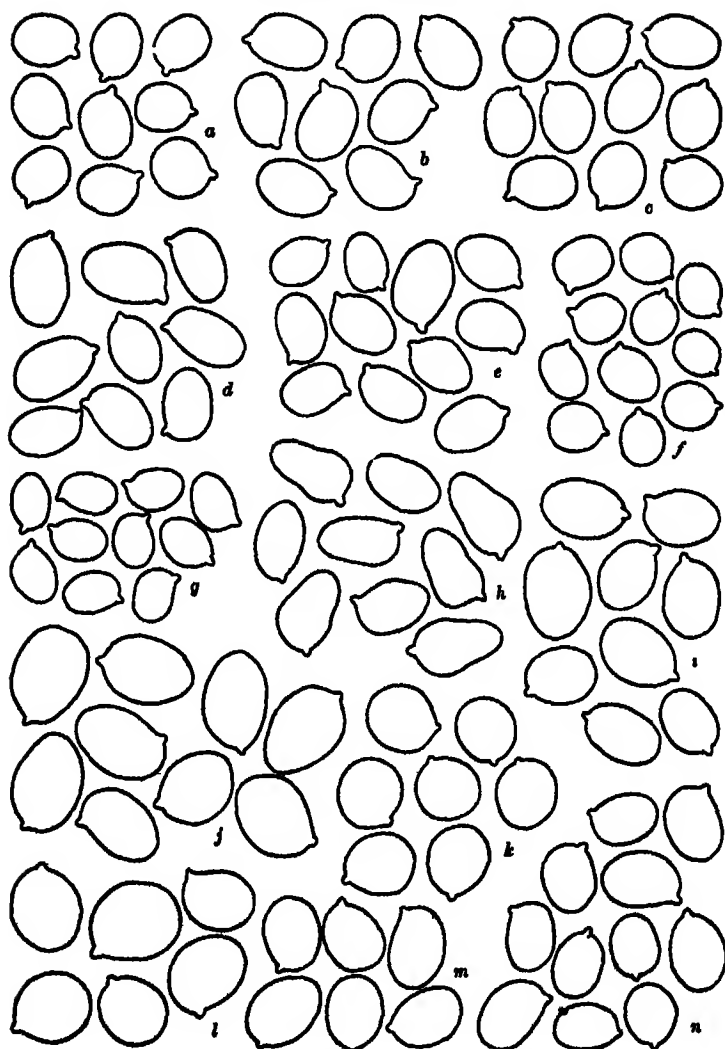


FIG 3 a, *A. Rodmani*, b, *A. Pattersonae*, c, *A. rufilucens*, d, *A. californicus*, e, *A. subnitens*, f, *A. bisulatus*, g, *A. cervinifolius*, h, *A. campestris*, i, *A. solidipes*, j, *A. argentatus*; k, *A. pilosporus*, l, *A. chlamydopus*, m, *A. praerimosus*, n, *A. Sterlingi*

is recognizable both in the wild state and under cultivation by the characters given above. Peck described the pileus of *A. brunnescens* as fibrillose, sometimes slightly squamose and silvery whitish when very young, becoming avellaneous to bay or brown. These characters at once separate his species from *A. vaporarius*. The description and illustration given in *Icones Farlowianae* (5) should be considered authentic for *A. brunnescens*. A comparison of it with Stewart's excellent photographs and description will clear up any questions regarding the two.

**AGARICUS STERLINGII** Pk. (Fig. 3n). — The spores of the type measure  $6-7.5(8) \times 4.5-5.5(6) \mu$ . An examination of the type showed the annulus to be thick and double. The spores and stature as well as the color of the dried specimens strongly indicate a similarity to *A. brunnescens*. The more conspicuous scales, however, together with the lack of pink colors in the gills, might distinguish it.

**AGARICUS RUTILESCENS** Pk. (Fig. 3c). — The spores of the type are quite variable in size, measuring  $(5.5)6-7(8) \times 4-5.5 \mu$ . In the majority of Kauffman's collections from the Rocky Mountains (11) they measure  $5-6.5 \times 4-5.5 \mu$ . In one, however, they are  $7-9 \times 5-6 \mu$ . The type consists of small or badly weathered specimens in which the pilei are areolate and not darker than ochraceous tawny. The annulus was missing on many of the specimens, but when present it appeared to be of the same type as that of *A. Rodmani*. The upper limb was rather broad, and the lower one flared only slightly. Kauffman described the annulus in his specimens as simple. It is impossible to be certain that Kauffman examined the type before publishing his comments, and it is doubtful whether his account (11) is based on a single species. Because of this it seems advisable to adhere to the original description and to observations on the type when interpreting Peck's species.

**AGARICUS RODMANI** Pk. (Fig. 3a). — The spores of the type are subglobose and measure  $5-6 \times 4-5 \mu$ . Hotson and Stuntz (9), who reported this species from Washington, give the measurements of the spores as  $6-7.5(8) \times 4-5 \mu$  and describe them as ellipsoid rather than subglobose. In all the material I have examined from eastern United States the spores have been exactly as in the type. Kauffman (10) published slightly different measurements, but

the spores of his specimens agree with those of the type Hotson and Stuntz noted that the annuli of the Washington specimens were poorly developed This is an added discrepancy Schäffer and Möller (22) consider Peck's species synonymous with *A. edulis* of Europe From the illustrations published by Herrfurth (8) under the name *Chtonia edulis* there can be little doubt that they are the same The only question remaining is in regard to the valid name This is a delicate problem in itself and involves other names which were used as specific epithets before *A. edulis* was raised to that rank Since the species has been commonly known in North America under the name Peck gave it, I see no advantage in substituting a name of doubtful standing Atkinson's excellent illustrations and study (1) seem to have been overlooked by most European investigators

**AGARICUS PATTERSONAE** Pk (Fig 3b, Pl X) — The spores of the type measure  $6-7 \times 4-4.5 \mu$  The photograph shown in Plate X accompanies the type The annulus and the decidedly scaly pileus are the most distinctive features of the species

**AGARICUS CALIFORNICUS** Pk (Fig 3d) — The spores of the type measure  $7-9(10) \times 4-5(6) \mu$  A small number of even larger spores are also present The gill edges are furnished with clavate thin-walled cheilocystidia which measure  $26-34 \times 7-12 \mu$  The annulus has a thick marginal band with scales on the under side To judge from the dried material, this is a rather long-stemmed species similar in stature to *A. silvaticus* The large spores at once distinguish it, however

**AGARICUS BIVELATUS** Pk (Fig 3f) — The spores of the type measure  $4-5 \times 3.5-4 \mu$  and are subglobose In stature the type resembles a robust *A. diminutivus*, but does not belong in its group The double annulus is well preserved The spores are similar to those of *A. Kauffmanii*, but the colors of the pilei should separate the two readily.

#### **AGARICUS COMPTULUS AND CLOSELY RELATED SPECIES**

**AGARICUS COMPTULUS** Fr (Fig. 2p). — The drawings of the spores were made from material determined by Bresadola and deposited at the New York Botanical Garden They measure  $4-4.5 \times 3.5 \pm \mu$ . This species, *A. micromegathus* Pk (Fig. 2t), *A. auricolor* Krieger (Fig 2s), *A. comptuliformis* Murr. (Fig 2r), *A. com-*

*ptulodes* Murr (Fig 2q), and *A. diminutivus* Pk (Fig 2u) all have spores which are practically identical. All the illustrations of the spores of American species given here are drawn from type material. In *A. diminutivus* the stipe may be smooth but peronate below the annulus or the sheath may be broken up into fibrillose patches. Peck's specimens show both conditions well. The type of *A. comptulodes* appears to be identical with the western form of *A. diminutivus*, which I have collected in large quantities in the Cascade Mountains of Oregon. Murrill (17) states that *A. comptuliformis* differs from *A. comptulus* in having larger and darker spores, but a comparison of the figures of both does not bear out the statement. The bright yellow color of Murrill's species should distinguish it, but immediately suggests identity with *A. auricolor*, see Coker (4). Murrill, however, recognizes the latter in Florida. It is more robust, and the taste is decidedly amygdaline. In general, species concepts in this group are very unsatisfactory at present in both North America and Europe, and are sadly in need of a critical study based on an examination of fresh specimens.

**AGARICUS LILACEPS** Zeller (Fig 2m). — This is apparently the largest species in the section. The annulus, the color change to yellow or tawny yellow when bruised or on drying, the spores, and pale pinkish tints all indicate its place in this group. It is at once distinguished from the other species by its slightly larger spores,  $5-6 \times 4-4.5 \mu$ . The drawings were made from type material.

#### AGARICUS CAMPESTRIS AND CLOSELY RELATED SPECIES

**AGARICUS SUBNITENS** Pk (Fig 3e). — The spores measure  $(5) 6.5-8(9) \times 4.5-5(6) \mu$  in the type. The annulus is fibrillose on the under side, but has an upper and a lower marginal limb. In the dried material it is paler than the pileus, and I doubt the value of the color of the ring as a distinguishing character.

**AGARICUS CERVINIFOLIUS** Zeller (Fig 3g). — The spores of the type are as Zeller described them and they remind one of those of species grouped around *A. silvaticus*, to which, however, it is not at all similar in other characters.

**AGARICUS CAMPESTRIS** Fr (Fig 3h; Fig 4r-t). — Figure 4g is of the cultivated variety, which clearly is distinct from the wild

variety The spores figured in 3h were from a fruiting body collected in the same pasture on the same day that those shown in Figure 4 r, s were found The ones shown in Figure 4t were taken from a California collection The spores in this species are apparently more variable than those in other species of the genus As yet, however, I have not had the opportunity to study a large series of collections in order to determine whether or not the somewhat ventricose spores of Figure 3h represent a distinct form In view of the variation in only the one pileus, I doubt whether they do

**AGARICUS SOLIDIPES** Pk (Fig 3i) — The spores of the type measure  $7-9 \times 5-6 \mu$  In some of its pilei the surface is broken into scales, whereas in others it is areolate The annulus is single, and the stature is that of *A campestris* I have received numerous collections of it from central Texas, where it is often very abundant in both spring and fall In that region it apparently takes the place of *A campestris*

**AGARICUS ARGENTATUS** Pk (Fig 3j) — The spores of the type measure  $8-10 \times 5.5-7 \mu$  and are broadly ellipsoid The apices are often slightly flattened, but no hyaline germ pore was visible The dark-colored young lamellae, the large spores, and the grayish pileus should be distinctive

**AGARICUS PILOSPORUS** Pk (Fig 3k) — The spores of the type measure  $6-7(8) \times 5-6.5 \mu$  It is well preserved and is similar to *A arvensis* in stature The dried pilei are of a pale cream color The annulus appears to be single, as in *A campestris* The scales on the stipe are due to the broken cuticle and not to a ruptured sheath The species appears very distinct

**AGARICUS CHLAMYDOPUS** Pk (Fig 3l) — The spores of the type measure  $8-9(10) \times 6-7.5(8) \mu$  The pileus dried a dead white and the gills black The ventricose stipe is sheathed by a white veil, which terminates in a cup, as described by Peck The combination of chocolate-colored young gills (as described by Peck), the veil characters, and the large spores make it very distinct

#### TROPICAL SPECIES

**Tropical Species** — Figure 4 b-n illustrates spores of tropical American species described by Murrill All the drawings are from type material In this figure b represents the spores of *A. angustifolius*,

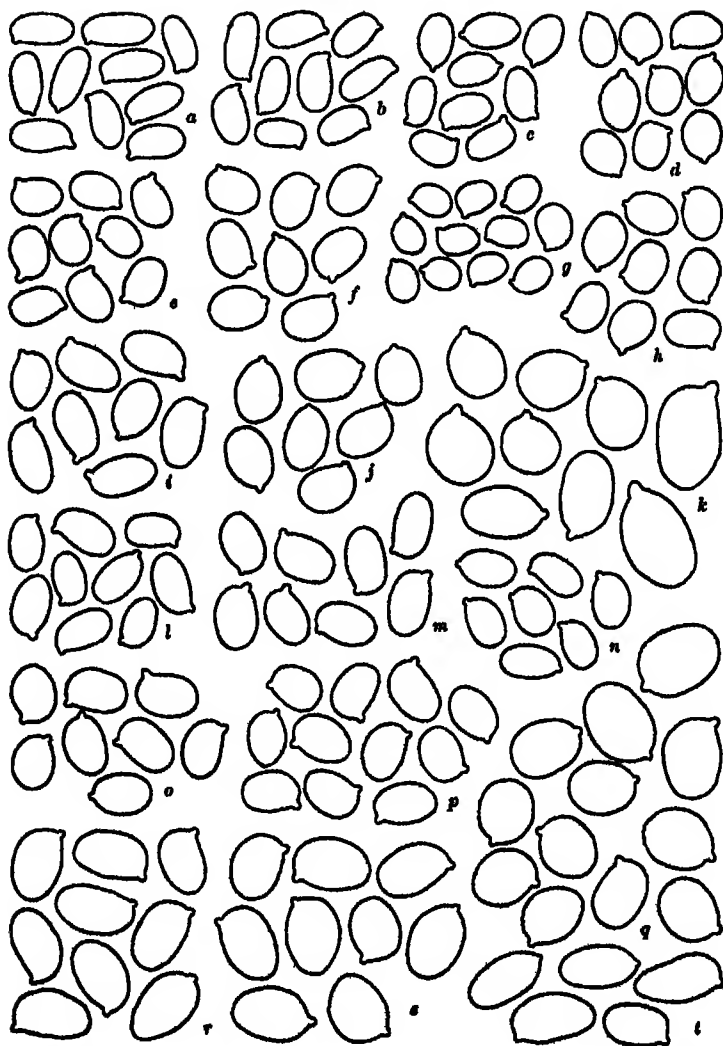


FIG 4 a, *A. echinatus*, b, *A. angustifolius*, c, *A. canchonenis*, d, *A. Earles*; e, *A. herradurensis*, f, *A. Hornei*; g, *A. Johnstoni*, h, *A. ochraceodiscus*, i, *A. praeagnus*, j, *A. Schaffers*, k, *A. subpratensis*, l, *A. subellipticola*, m, *A. venus*, n, *A. zuchlensis*; o, *A. alabamensis*, p, *A. praeagniceps*, q, *A. campestris* (cultivated form); r-t, *A. campestris*, wild form

c, of *A. cinchonensis*, d, of *A. Earlei*, e, of *A. herradurensis*, f, of *A. Hornei*, g, of *A. Johnstoni*, h, of *A. ochraceidiscus*; i, of *A. praemagnus*, j, of *A. Schafferi*; k, of *A. subpratensis*, l, of *A. subsilvicola*, m, of *A. venus*, and n, of *A. zuchilensis*

The spores of *A. angustifolius* resemble those of *A. echinatus* in size and shape, but these are apparently the only similarities between the two. In *A. cinchonensis* the spores measure  $4.5-5 \times 2.5-3 \mu$ , and cheilocystidia, which measure  $28-34 \times 9-13 \mu$ , are abundant. The spores of *A. Earlei* and *A. herradurensis* measure  $4.5-5 \times 3.5-4 \mu$ . The annulus in the latter species is described as almost basal, whereas in the former it is said to be apical. In all other respects they lack distinguishing characters. The spores of *A. Hornei* measure  $5.6-5 \times 4.4-5 \mu$ . *A. Johnstoni* is characterized by exceptionally small spores,  $4.4-5 \times 2.5 \pm \mu$ , which are pale chocolate-brown under the microscope.

In *A. ochraceidiscus* the spores measure  $4.5-5 \times 3.3-5 \mu$ , the cheilocystidia,  $26-35 \times 7-12 \mu$ . *A. praemagnus* has larger spores,  $6-7(8) \times 4.4-5 \mu$ , and cheilocystidia which resemble sterile basidia. The thick flesh is characteristic even in the dried condition. *A. Schafferi* resembles *A. augustus* in the ornamentation of the pileus, but has much smaller spores,  $5.6-5 \times 4.4-5 \mu$ , which are very dark chocolate-brown under the microscope. The spores of *A. subpratensis* are of two distinct ranges in the type. The larger individuals measure  $8-10 \times 5-6 \mu$  and are not so numerous as the smaller ones, which measure  $6-7.5 \times 5-6.5 \mu$ . The latter measurements should be considered typical. When dry the flesh of the pileus is thick and almost powdery or punklike in consistency. The spores of *A. subsilvicola* separate it from *A. silvicola*. They measure  $5-6 \times 3.3-5 \mu$ . *A. venus* has spores  $5.6-5 \times 3.3-5 \mu$  and cheilocystidia  $15-20 \times 9-12 \mu$ , which are thin-walled. *A. zuchilensis* has spores  $5-6 \times 2.5-3 \mu$ . The type is in very poor condition.

#### MISCELLANEOUS SPECIES

**AGARICUS PRAERIMOSUS** Pk. (Fig. 3m) — The spores of the type measure  $6.5-8 \times 5-6 \mu$ . The cheilocystidia, which measure  $30-35 \times 10-12 \mu$ , are thin-walled and clavate. The annulus is double.

**AGARICUS ECHINATUS** Fr. (Fig. 4a) — I have collected this species



in New York, Michigan, and California. The drawings of the spores are of collection 10982. I have studied Kauffman's type of *Hypholoma vinosum*, but am unable to find differences which separate it as a species from *A. echinatus*. The gills are typically free, but at times may reach the stipe and apparently become spuriously attached. The scales on the pileus are powdery and come in perfectly developed specimens. One seldom finds them in such condition, however, because the expansion of the pileus usually reduces them to powder. Specimens which I collected in 1929 and which Kauffman determined as *H. vinosum* were similar in color to *A. echinatus*. The stipe is "Prussian red" to "Indian red" beneath the umber powdery coating, when it is squeezed, a small amount of reddish sap is exuded.

**AGARICUS PRAEMAGNICEPS** Murr (Fig 4p) — Through the courtesy of Dr W A Murrill authentic material of this species was obtained for drawings of the spores. They measure  $5-6.5 \times 3.5-4 \pm \mu$ . Hyaline lactiferous hyphae are common in the pileus and the gill trama. The basidia are four-spored.

**AGARICUS ALABAMENSIS** Murr (Fig 4o) — The spores of the type measure  $(5.5)6-7 \times 4-4.5 \mu$ , and are a very dark chocolate-brown under the microscope.

**Agaricus ciscoensis**, sp nov (Fig 1o) — Pileus 2-3.5(4) cm latus, convexus, demum planus, siccus, subfibrillosus, brunneus, lamellae confertae, latae, incarnatae demum fuscae, stipes 3-5 cm longus, 3-5(6) mm crassus, valde radicans, annulus superus tenuis, albidus, fugax; sporae  $7-8 \times 4.5-5 \mu$ , basidia tetraspora. Specimen typicum legit E A Smith n 1 prope Cisco, Texas, Sept 10, 1935, in Herb Univ Mich conservatum.

Pileus 2-3.5(4) cm broad, convex, becoming plane, surface dry and slightly silky-fibrillose, dull brown (near "cinnamon-brown"), fading somewhat on drying, disc darker owing to a denser fibrillose covering, flesh thin, whitish, sordid reddish brown in age, odor and taste not recorded; lamellae close, free but approaching the stipe, moderately broad, pink when young, finally dark chocolate-brown, edges even, stipe 3-5 cm long, 3-5(6) mm thick, tapering slightly above a somewhat bulbous base, usually with a long pseudorhiza penetrating into the soil from the base of the bulb, surface smooth and silky above and below the superior annulus, whitish but becoming sordid vinaceous

brown or grayish brown over all in age or upon drying (in one the stipe stained reddish when handled), stuffed, becoming hollow, annulus single, very narrow (1.5–2.5 mm), whitish or pallid, silky above, somewhat fibrillose below, thin, sometimes evanescent, cheilocystidia basidia-like and not otherwise differentiated, basidia four-spored, spores  $7-8 \times 4.5-5 \mu$ , smooth, ellipsoid, dark chocolate-brown under the microscope

Scattered on soil under live oaks. Known only from the type locality. In many respects it reminds one of *A. diminutivus*, but the radicating stipe, the larger spores, and the brown pileus at once distinguish it. The pseudorhiza of this species is well differentiated. Owing to the difficulties of digging it out of the hard soil its point of origin was not determined.

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*Agaricus crocodilinus* Murr X 1



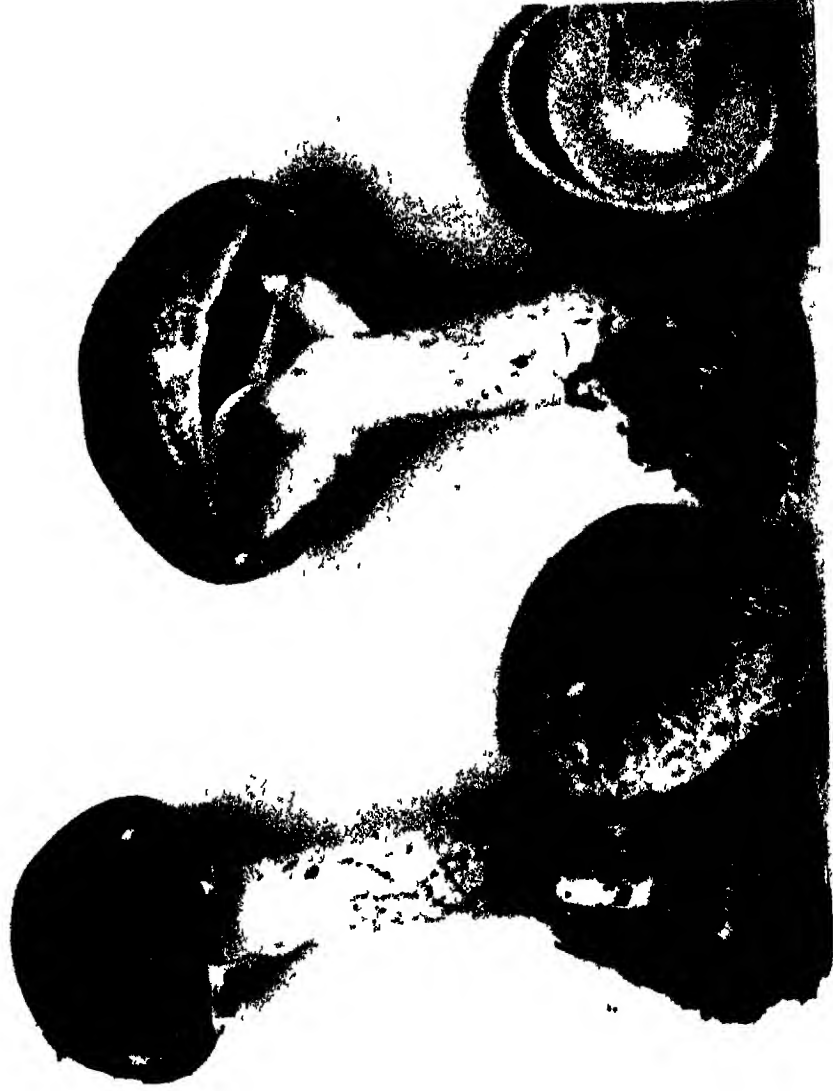
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PLATE II



*Agaricus crocodilinus* Murr.  $\times 1$





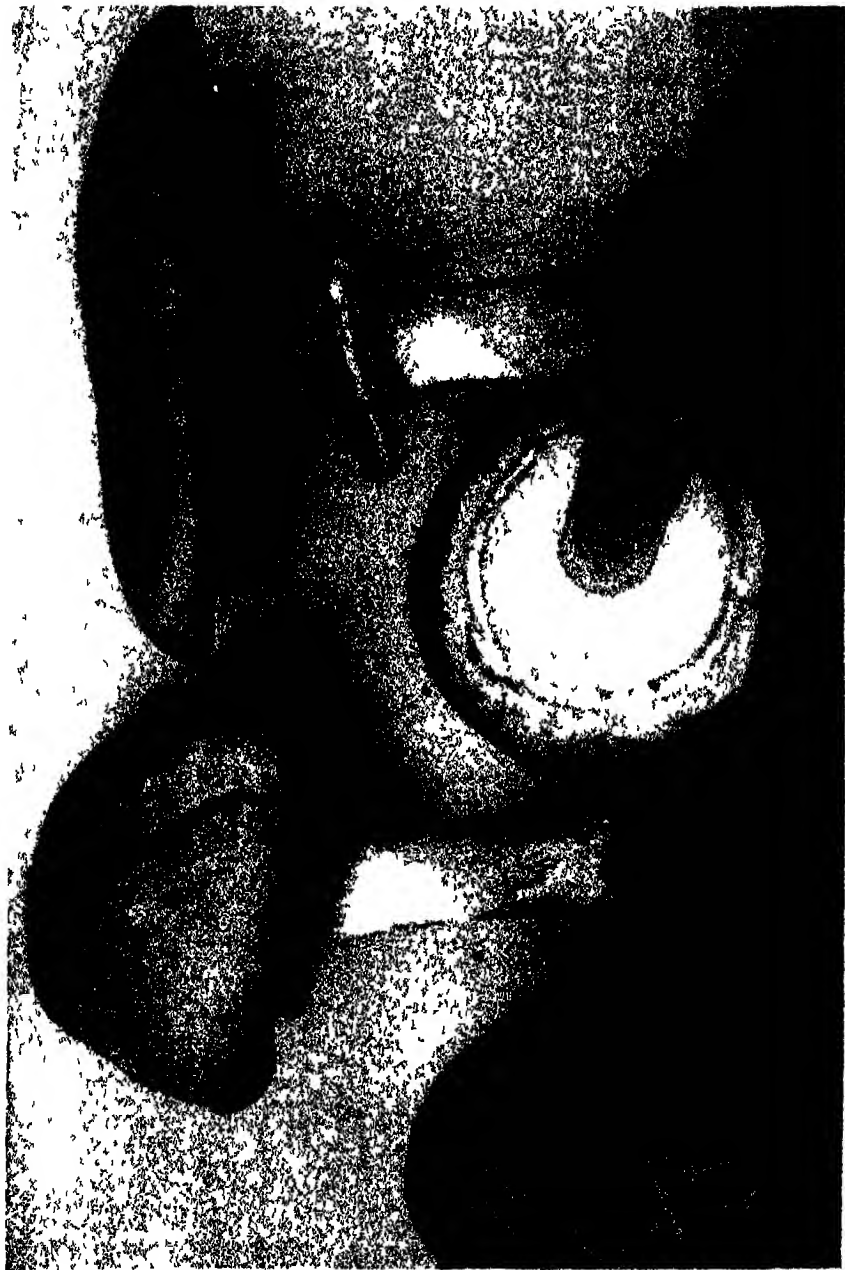
*Agaricus subrutilescens* (Kauff.) Hotson & Stuntz  $\times 1$





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PLATE IV



*Agaricus glaber* Zeller X 1





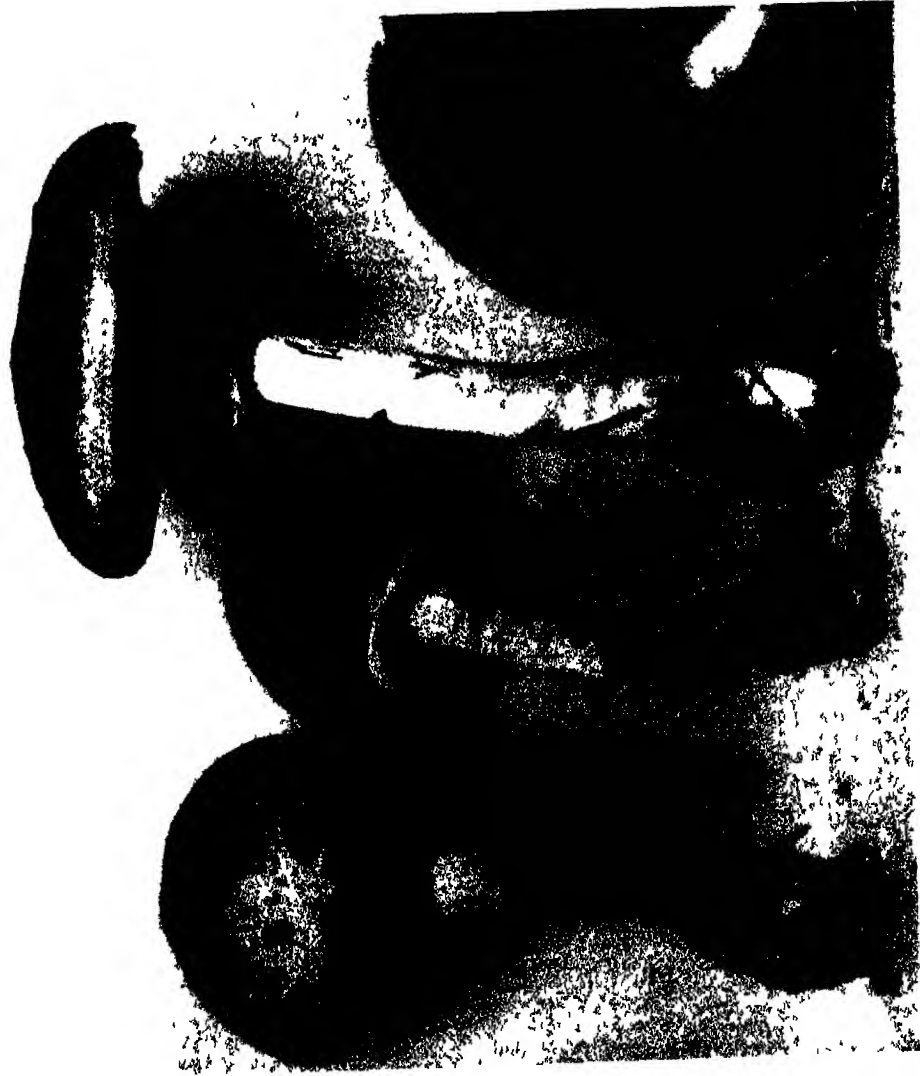
*Agaricus glaber* Zeller X 1





*Agaricus silvaticus* Fr. young specimens  $\times 1$

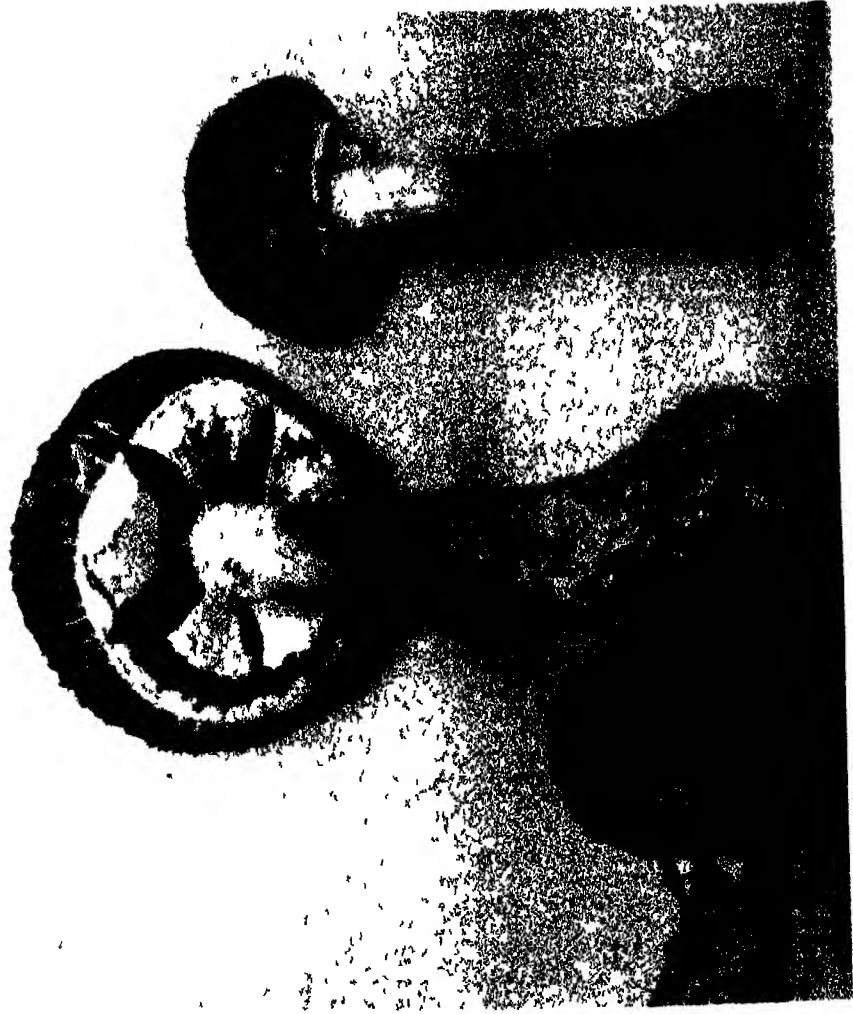




*Agaricus silvaticus* Fr. older specimens  $\times 1$







*Agaricus haemorrhoidarius* Schulz in Kalch  $\times 1$





*Agaricus placomyces* Pl.  $\times 1$



SMITH

PLATE X



*Agaricus Pattersonae* Pk X 1



# MORPHOLOGICAL STUDIES ON THE SEED OF SNAPDRAGON (*ANTIRRHINUM* *MAJUS* L.)

EDWARD F. WOODCOCK

A STUDY of the literature on *Antirrhinum majus* L. gives very little information in regard to the morphology of the seed. Much has been written about its culture, genetics, and pathology. Propach (2), in his cytological studies of this plant, finds that the embryo sac develops in the normal manner. Klemm (1) states that the anatropous ovules are borne on an axile placenta. His figure of the longitudinal section of a single ovule shows the micropyle and thick integument, but no detail of the embryo sac. This paper deals with the seed morphology in *Antirrhinum majus* L., a member of the Scrophulariaceae.

## DESCRIPTION AND DISCUSSION OF THE MORPHOLOGY OF THE SEED

The stages of seed development were studied by means of microtome sections cut 10 microns thick and stained with Delafield's haematoxylin.

The two-loculed compound pistil has axile placentation and many ovules in each locule. The placental region is slightly enlarged and projects into each locule. The anatropous ovules are smooth when young, before fertilization occurs (Pl I; Pl. II, Fig. 1). Each ovule is elongated and rounded, and in cross section is circular in outline.

There is only one integument, and it is several cells in thickness (Pl II, Fig. 1). The epidermis consists of flattened cells, each of which has very little convexity in its outer wall. The cells which surround the micropylar canal are somewhat elongated. At the time of fertilization the young embryo sac is surrounded by a one-layered nucellus made up of cells, each of which has a centrally placed nucleus and a dense cytoplasm. These cells persist during most of the development of the seed. The embryo sac is circular in cross section, elongated, and narrowed in its chalazal region. The free



part of the funiculus is so short that the micropylar opening is almost in contact with the wall of the locule

As growth proceeds in the ovule it enlarges rapidly, and marked changes occur as the fertilized egg divides to form a three-celled filamentous suspensor and a two-celled embryo (Pl II, Fig 6) The embryo sac increases and becomes almost completely filled with cellular endosperm, in which no starch grains occur The cells in the central region of the endosperm tissue are larger and more vacuolated than those in the peripheral region, where the outer cells form a rather distinct layer In the narrowed chalazal portion of the embryo sac the endosperm is in the free nuclear condition The cells of the nucellus are somewhat flattened because of the pressure of the cellular endosperm At intervals on the surface of the ovule there are interconnecting ridges (Pl II, Fig 2), which have arisen by the bulging outward of the outer wall of adjacent epidermal cells The height of the ridges varies in different parts of the ovule, and the radial length of the individual cells which form each ridge is not always the same The outer wall of the epidermal cells between the ridges is distinctly convex In the cell cavity of the epidermal cells there is a dense granular deposit next to the outer wall of the cell

The suspensor undergoes no changes as the embryo continues its development Numerous nuclear and cellular divisions occur in the embryo to produce a many-celled spherical structure (Pl II, Fig 4, Pl III, Fig 7) While these changes are taking place in the embryo the extent of the endosperm tissue increases and the cells of the nucellus layer and integument become somewhat flattened (Pl I, Pl II, Fig 3) The cells of the outer layer of the endosperm are square in radial section, and smaller than those in the adjacent endosperm The few starch grains which appear in the endosperm vary in size Those in the outer layer of cells are smaller than those in other parts (Pl II, Fig 5) of the endosperm

As the embryo develops further it forms two cotyledons, which are semicircular in cross section and about one third as long as the entire embryo (Pl III, Fig 9) No well-marked plumule develops at the base of the cotyledons The embryo is straight, centrally placed, and located in a cavity in the endosperm produced by the absorption of the cellular endosperm formed earlier in the seed development In the fairly well marked layer of cells forming the periphery of the cellular endosperm the number and size of the starch grains is less

than in the adjacent endosperm tissue. Immediately surrounding the cavity in which the embryo is located there is a region of somewhat compressed endosperm cells in which no starch occurs. The layer of nucellus cells is much compressed, and the cells of the integument are somewhat flattened. At this stage of development the young seed is light brown, and the outer wall of the epidermal cells and the common wall between the cells which form the ridges are much thickened and pitted.

There occur but few other changes in the embryo and endosperm as the seed matures. In the mature stage (Pl I, Pl III, Figs 10, 12) the starch-free and the starchy endosperm are quite distinct from each other. All the cells of the nucellus layer and the integument, except the epidermal layer of the latter, have been absorbed by the endosperm, and in the mature seed the seed coat consists of an epidermal layer of cells separated from the endosperm by the crushed remains of the nucellus and inner cells of the integument. The granules in the lumen of the epidermal cells and the pits in the walls of these cells are very evident in a cross section of the seed coat and adjacent tissue (Pl III, Fig 11). The outer tangential wall of each cell of the epidermal layer of the endosperm is thickened and convex. Numerous spherical starch grains, which vary in size, are scattered through the lumen of the endosperm cells (Pl III, Fig 8).

#### SUMMARY

The ovule of *Antirrhinum majus* L. is anatropous and somewhat elongated, and appears almost circular in outline when cut in cross section. As the seed matures the cellular endosperm increases, and the nucellus, one layer of cells in thickness, becomes disorganized. All the cells of the integument, except the epidermal layer, also are crushed. As a result, the seed coat of the mature seed consists almost entirely of a single layer of cells, some with hairlike outgrowths, which are arranged in interconnected ridges. The embryo is a typical dicot type, straight and centrally placed in the starchy endosperm.

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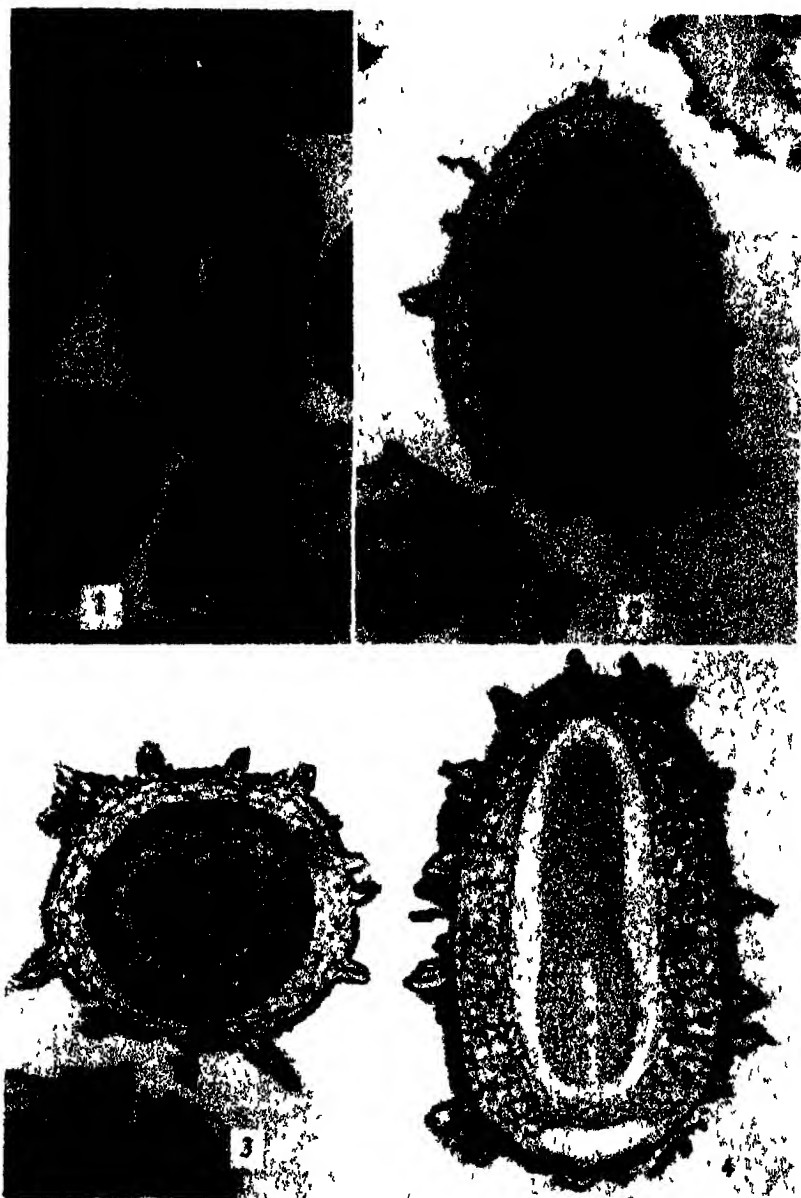
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## EXPLANATION OF PLATE I

## Stages in development of seed

- FIG 1 Longitudinal and cross section of ovule  $\times 79$
- FIG 2 Longitudinal section of ovule, with embryo in spherical condition  $\times 44$
- FIG 3 Cross section of ovule shown in Figure 2 The embryo is evident in the center of the endosperm  $\times 33$
- FIG 4 Longitudinal section of mature seed The seed coat consists almost entirely of the epidermis of the integument  $\times 35$



Stages in development of seed of *Antirrhinum majus* L.

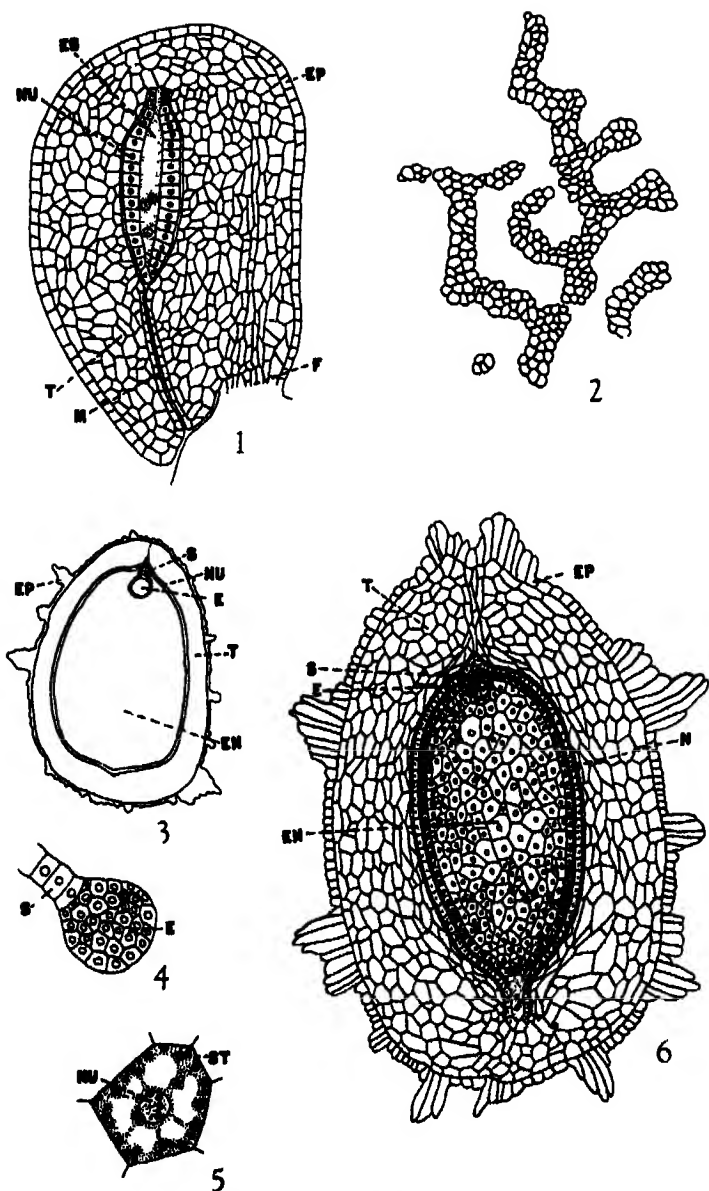
## NOTE

### Seed of *Antirrhinum majus* L

All figures drawn with the aid of camera lucida. The following abbreviations are used: CO, cotyledons; E, embryo; EN, endosperm; EP, epidermis; ES, embryo sac; F, funiculus; G, granules; H, hypocotyl; M, micropyle; N, nucleus; NU, nucellus; R, radicle; RE, remains of nucellus and integument; S, suspensor; SC, seed coat; ST, starch; T, integument.

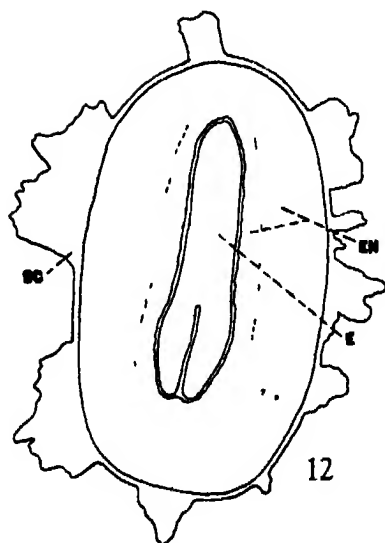
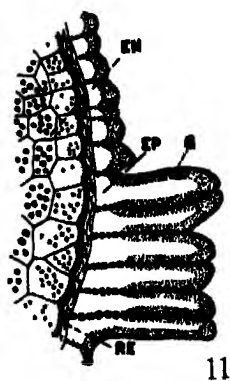
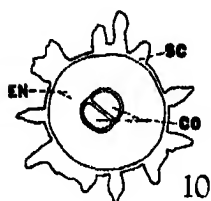
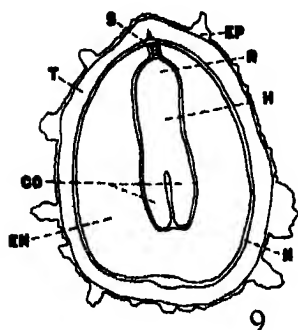
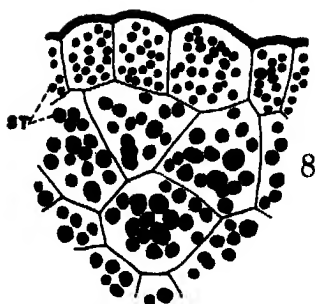
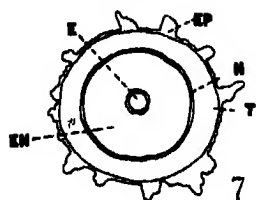
### EXPLANATION OF PLATE II

- FIG. 1 Longitudinal section of young ovule, with embryo sac surrounded by nucellus, one layer of cells in thickness.  $\times 207$
- FIG. 2 Cross section of ridges.  $\times 75$
- FIG. 3 Longitudinal section through ovule at the stage when the embryo is in the spherical condition and the endosperm in the cellular condition.  $\times 40$
- FIG. 4 Detail of embryo and suspensor shown in Figure 3.  $\times 207$
- FIG. 5 Endosperm cell from stage shown in Figure 3.  $\times 430$
- FIG. 6 Longitudinal section through young ovule, showing cellular detail. Embryo in the two-celled stage. Endosperm differentiated into inner, large-celled region and outer, small-celled epidermal region. Some of the epidermal cells of the integument enlarged to form ridges shown in Figure 2. Nucellus layer compressed. No starch present.  $\times 75$

Seed of *Antirrhinum majus* L.

### EXPLANATION OF PLATE III

- FIG 7 Cross section of ovule shown in Plate II, Figure 3  $\times 40$
- FIG 8 Cellular detail of outer portion of endosperm in mature seed Starch grains and cells are smaller in epidermal layer  $\times 430$
- FIG 9 Longitudinal section of nearly mature seed  $\times 40$
- FIG 10 Cross section of mature seed, the section passes through the cotyledons  $\times 40$
- FIG 11 Cross section of outer portion of mature seed The epidermis of the integument, with its numerous brown granules, is separated from the endosperm by the compressed remains of the nucellus and the inner cells of the integument  $\times 207$
- FIG 12 Longitudinal section of mature seed The seed coat consists of the epidermis of the integument and the broken-down cells of the nucellus and integument The endosperm next to the embryo has no starch grains The amount of starch in the outer portion of the endosperm region is shown in Figure 8  $\times 75$



Seed of *Antirrhinum majus* L.





# FORESTRY



## SOME RESUPINATE POLYPORES FROM THE REGION OF THE GREAT LAKES XI

DOW V BAXTER

IN THE preparation of these monographic studies of the resupinate polypores of the North American continent it has been the object to supplement the material found in various American and European herbaria by records obtained directly in the field. In addition to specimens gathered in the United States and in certain Canadian provinces, collections have been made on seven expeditions to Alaska, the Yukon, and the Northwest Territories

Descriptions of ten resupinate polypores are presented in this paper<sup>1</sup> *Poria ferox* is described as a new species. In addition, the characteristics of resupinate polypores in culture are discussed, and the growth features of these polypores are presented in Table I (p 146)

*Trametes rigida* Berk. and Mont. 1849. Not

*Polyporus rigidus* Leil. 1844

*Polystictus extensus* Cooke in Sacc, Syll Fung, 6 244 1888

*Polystictus rigens* Sacc & Cub in Sacc, Syll Fung, 6 274 1888

*Coriopolus rigida* (Berk & Mont) Murr, North American Flora, 9 75 1908

(Plates I-III)

Type, cotypes, and important specimens.

*Trametes rigida* Berk & Mont, Bahia, Brazil Type Herb. of Bresadola, Stockholm

<sup>1</sup> Throughout the work upon these monographs I am indebted to many individuals and institutions for suggestions, help, and privileges extended to me. My appreciation is expressed particularly to the men who have accompanied me on my seven expeditions to Alaska, the Yukon Territory, and the Northwest Territories. Much credit is due them for aiding in the collection and care of the specimens and for living at times under rather difficult circumstances. I am under obligation to Professors T. G. Hallé and Gunnar Samuelson, of the Naturhistoriska Riksmuseet in Stockholm, with whom I have had the pleasure of association. Thanks are rendered several American institutions and scholars also. To the authorities at the New York Botanical Garden, to Dr. W. H. Long, Albuquerque, New Mexico, to the staff of the Division of Pathological and Mycological Collections of the United States Department of Agriculture, and to the staff of the Division of Forest Pathology of the same department I am especially indebted. Dr. Ross Davidson, Dr. W. A. Campbell, and Dr. C. Audrey Richards of that office kindly furnished certain cultures of fungi which were used in this study.

TABLE I  
GROWTH CHARACTERISTICS OF RESUPINATE POLYPORES ON MALT AGAR

NAME	IN LIGHT					IN DARK					
	Rate in mm 2 weeks	Color (Redgway)	Texture and form	Character of margin	Agar discoloration	Pore formation	Rate in mm 2 weeks	Color (Redgway)	Texture and form	Agar discoloration	Pore formation
<i>Peziza necrurus</i> on <i>Populus balsamifera</i> from Moose Pass, Alaska	25.0	White	Granular	Indefinite	None	None	34.8	White	Woolly radiating	None	None
<i>Peziza squarrosa</i> on <i>Betula lanuginosa</i> from Moose Pass, Alaska	11.2	"Buckthorn brown" to "ochraceous tawny" to "Mars brown"	Silky to chamois, concentric	Indefinite	Under mat	None	15.5	White to ivory-yellow buff	Cottony, slightly concentric	None	None
<i>Polyporus ustus</i> on <i>Quercus</i> sp. from Aus Arbor, Michigan	41.0	White to ivory-yellow	Silky, concentric	Indefinite	None	None	41.0	White to ivory-yellow	Cottony concentric	None	None
<i>Polyporus radiatus</i> on <i>Betula lanuginosa</i> from Moose Pass, Alaska	26.2	"Chamois" to "honey-yellow" to "Isabella color"	Silky to woolly, concentric	Indefinite	Under mat	None	24.6	White to Isabella color to honey-yellow, to Sudan brown	Silky to mossy cottony concentric	Slight	None
<i>Fraxinus repens</i> on <i>Yucca filifera</i> from Shark, Florida	41.0	White to "saddle-buff" to "cream-buff"	Cottony, concentric to radiating	Indefinite border	None	None	41.0	Mostly white to cream-buff to light ochraceous buff	Cottony radiating	None	None
<i>Trametes repens</i> on <i>Quercus shumacheri</i> from Fort White, Florida	29.4	White to cream-buff	Cottony, concentric, radiating	Indefinite	None	None	41.0	White to warm buff to "clay-color"	Cottony, radiating	None	None
<i>Trametes versicolor</i> on <i>Picea canadensis</i> from Kodiak Island, Alaska	28.5	White to "lilac-buff"	Arachnoid to porous	Indefinite	None	Abundant	28.0	White to lilac-buff	Arachnoid to porous	None	Abundant
<i>Trametes versicolor</i> from cotton mill in Rhode Island	34.5	White	Cottony, concentric	Indefinite	None	None	41.0	White	Cottony, concentric	None	None

*Trametes rigida* Berk, Florida, Calkins 149 Herb Ellis, "types ex N Orleans for resupinata Herb of Bresadola, Stockholm"

*Polyporus Steinkeithanus* Lev and Berk Ex herb Patouillard, Herb of Bresadola, Stockholm *Sensu* Bresadola

*Polyporus Beaumontii* B & C Rav Fung

Fructification pileate or resupinate, pileus sessile, thin, coriaceous to rigid, imbricate, 0.1-0.2 × 0.1-3.0 × 2-6 cm, surface hirsute, zoned, concentrically furrowed, margin "avellaneous," "cinnamon-buff," "dark Quaker drab," drab behind, margin very thin, undulate to lobed, "clay-color" beneath, sterile for a distance of 0.5-1 mm, context "clay-color," up to 2 mm thick, tubes mostly 1 mm or less in length; mouths "tawny olive," 2-4, mostly 3-4, to a mm, dissepiments thick, resupinate specimens often found in orbicular patches on substratum, separable, spores smooth; hyphae occasionally septate and seldom branched, often collapsed, 3-4  $\mu$  in diameter

*Allied species* — That this plant has long been confused with others is indicated by the Lloyd Letter 69, April, 1919 (10) "Morgan misreferred it [*Trametes Morgani*] to *T. rigida*, a southern plant with hardly a suggestion of it The European history is just as confused Romell distributed it as *Pol. albo-carneogilvudus* . "

*Polyporus albo-carneogilvudus*, which occurs on oak branches (still attached to the trees), does not grow in habitats characteristic of *Trametes rigida* The fruiting body of *Pol. albo-carneogilvudus* differs from that of our plant in its pink color

*Trametes rigida* is unlike *T. Morgani* Lloyd in that the upper surface of the pileus is covered by soft, closely appressed fibrils (11) and is not coarsely hirsute or stigose Both plants occur on hardwoods Although many exceptions may be observed, the majority of specimens of *T. rigida* collected are not so thick as those of *T. Morgani*

*Trametes serialis* in turn may suggest *T. Morgani*, but it is coniferous, whereas *T. Morgani* appears on hardwoods, commonly on poplar, furthermore, the pore mouths of *T. serialis* remain white or whitish, but those of *T. Morgani* are more often light brown The spores of *T. Morgani* are 12 × 6  $\mu$  (Lloyd); those of *T. serialis*, 7-9 × 2-3  $\mu$  (Shope)

*Trametes serpens* may suggest *T. rigida* The pore mouths of *T. serpens* are large, about 1 to a mm, whereas those of *T. rigida*

average 2-4, and are mostly 3-4, to a mm Overholts (12) states that hyphal pegs in *T. serpens* are visible under a hand lens

Since resupinate specimens of *Fomes fraxinophilus* are corky, white or whitish, and possess a white to light-brown context, and since the mouths of the tubes average 2-3 to a mm, some difficulty may be encountered in separating it from members of the group under discussion The spores of *F. fraxinophilus* are ellipsoid to ovoid,  $6-8 \times 5-6 \mu$ , and not cylindric-ellipsoid as in the species of *Trametes* discussed

**Cultures** — Isolated from *Quercus Shumardii*, Fort White, Florida, and from *Nyssa biflora*, Stark, Florida The mycelium from both isolates exhibits a concentric to radiating type of growth in agar cultures, and the isolates are similar in their growth habits on wood blocks The white to "cartridge-buff" or "cream-buff" mycelium covers hardwood blocks (red gum), but merely radiates in strands or fanlike growth over white-pine blocks and does not cover such wood in one-year-old cultures No pore formation has occurred

Since fruiting bodies of *Trametes rigida* and *T. Morgani* have been confused, their cultures should be compared An isolate of *T. Morgani* from *Quercus* sp likewise is inhibited in its growth on white-pine blocks, but the radiating mycelium does not spread over the wood in coarse strands as does that of *T. rigida* The mycelium, furthermore, is whitish, or "light buff" and does not form the thick chamois-like covering on hardwood blocks that is characteristic of the clay-colored ("cartridge-buff") fungous growth of *T. rigida*

**Habitat** — *Acer floridanum*, *Carya* sp, *Fraxinus americana*, *F. nigra*, *Liquidambar styraciflua*, *Nyssa aquatica*, *N. biflora*, *Pinus echinata*, *Populus* sp, *Quercus laurifolia*, *Q. Shumardii*, *Salix nigra*

**Distribution** — Alabama, Florida, Georgia, Kentucky, Louisiana, North Carolina, Ohio, Pennsylvania, South Carolina, Tennessee, Texas

**Occurrence** — This tropical plant is common in parts of the southern United States on stumps and prostrate logs of the low wet woods, swamps, and bayous

***Poria ferox* Long & Baxter, sp. nov**

(Plate IV)

## Type

*Trametes ferox* on *Juniperus virginiana*, Casteel, Ozark National Forest W H Long U S Forest and Timber Disease Surv 12150 1912

Fructificatio annua vel perennis, coriacea, plus minusve 15 cm effusa irregulariter in ligno carbonario, inseparabilis, 3 mm crassa, margo primum sterilis, crassus, rotundatus, undulatus, tomentosus, 1 mm latus, pallide ochraceus vel ochraceo-cinnamomeus, aetate fertilis, subiculum pallide ochraceum, 0.3 mm crassum, tubi plerumque 0.5–1 mm longi, interdum in stratis sed plerumque obscure stratosi, aperturae ochraceae, siccitate aliquando pallide ochraceae vel eae apud marginem fructificationis nigrescentes,  $\frac{1}{2}$ – $\frac{1}{3}$  mm crassae, basidia 4-spora,  $10\text{--}14 \times 5\text{--}7 \mu$ , spores hyalinae,  $5\text{--}6 \times 3 \mu$ , hyphae raro furcatae,  $3\text{--}4 (5) \mu$ , plerumque non incrustatae, anastomoses absunt

Fructification annual or perennial, effused for 15 cm or more in irregular patches on charred or old wood, inseparable, up to 3 mm thick, margin at first sterile, thick, rounded, undulating, tomentose, up to 1 mm wide, "cartridge-buff" to "cinnamon-buff," becoming fertile with age, subiculum "cartridge-buff," up to 0.3 mm thick, tubes mostly 0.5–1 mm long, sometimes stratoses, but indistinctly so, mouths "cartridge-buff," "pinkish buff," sometimes drying to "clay-color" or those at margin of fructification becoming blackish, 2–5, mostly over 3, to a mm, basidia 4-spored,  $10\text{--}14 \times 5\text{--}7 \mu$ , spores hyaline,  $5\text{--}6 \times 3 \mu$ , hyphae seldom branched,  $3\text{--}4 (5) \mu$ , mostly not encrusted; clamp connections not present.

*Allied species* — *Poria ferox* is allied to *Polyporus unius* (*Poria medulla-panis*), from which it differs in that its hyphae are seldom branched. The difference in spore size is also to be stressed. The spores of *Pol. unius* are mostly ellipsoidal,  $4 \times 5 \mu$ , whereas those of *P. ferox* are generally oblong,  $5\text{--}6 \times 3 \mu$ . *Pol. unius*, so far as is known, occurs only on frondose species, but *P. ferox* is found on juniper. Both size and character of the dissepiments of the pore mouths in *P. ferox* suggest *Pol. unius* (*P. medulla-panis*). The blackish tubes at the margin of the fructification of *P. ferox* and the small size of the pore mouths in many specimens



will distinguish it from *T. serialis*, which, like it, is also found on conifers. In such collections of *P. ferox* the mouths average 5-6 to a mm, but in *T. serialis* only 3 to a mm. The spores of *P. ferox* are slightly shorter,  $3 \times 5-6 \mu$ , than those of *T. serialis*,  $2.4 \times 7-10 \mu$ .

*Habitat* — *Juniperus monosperma*, *J. virginiana*

*Distribution* — Arkansas, New Mexico

*Decay* — This fungus has been found several times by Dr Long on dead timber, fallen or standing. The decay is a brown cubical rot. Thick mats of whitish mycelium form between the checks in the wood and remind one of those in wood decayed by *Fomes pinicola*. The cubes are characteristically smaller than those observed in most rots of this nature. Many of the cubes are only 1-2 mm in diameter.

*Poria versipora*<sup>2</sup> (Pers.) Romell in Svensk Bot  
Tidsk., 19. 1926

*Polyporus versiporus* Pers., Myc. Eur., 2 105, p. p., Romell in Svensk Bot Tidsk., 20 19 1926

*Hydnum paradoxum* (Schröd.) Fr., Syst. Myc., 1 424 1821

*Hydnum pseudo-boletus* DC., Fr., Syst. Myc., 1 424 1821

*Irpez paradoxus* (Schröd.) Fr., Fr. Ep., 522 1838, Hym. Eur., 612 1874

*Hydnum obliquum* (Schröd.) Fr., Syst. Myc., 1 424 1821

*Irpez obliquus* (Schröd.) Fr., El., 147 1828, Hym. Eur., 622 1874

*Polyporus radula* Pers., Myc. Eur., 2 107 1825 (non *Polyporus radula* Pers. ex Fr. 1821; non Bres., Bourd. et Gals.)

*Irpez deformis* Fr., El., 147 1828; Hym. Eur., 622 1874

*Poria mucida* (Pers.) Fr. sensu Bres., Hym. Hungarici Kmetziani, 84 1897

*Poria consobrina* Bres. sensu Bourd. et Gals., Hym. de France, 671 1927

*Polyporus vaporarius* (*Poria vaporaria*) Fr., in English literature

Type, cotype, and important specimens

*Irpez paradoxus* (Schröd.) Fr. on Fagus. "Typicus" Herb. of Bresadola, Stockholm.

*Irpez obliquus* Fr. from Boudier. Herb. of Bresadola, Stockholm.

*Poria mucida* Pers., "orig. exempl." Persoon. Herb. of Bresadola, Stockholm.

*Irpez deformis* Fr., det. Bresadola, Göteborg, 1897. Herb. Mycolog. Lars Romell 13023, Stockholm.

<sup>2</sup> It is to be noted in the literature of this and other species that there is considerable confusion in the nomenclature, some of the specimens being assigned to *Polyporus*, some to *Poria*, and where this confusion exists it frequently happens that the specific name is not in grammatical agreement with the name of the genus. In the present paper the incorrect forms have been retained only where there is direct reference to the older synonymy, the correct forms being used elsewhere.

- Irpez obliquus* (Schr.) Fr., on *Quercus* "Typicus" Prončow, 1892 Leg Andr Kmet Herb of Bresadola, Stockholm  
*Polyporus versiporus*, Särö, 1914 Herb Mycolog Lars Romell 13035, Stockholm  
*Poria ochracea* Murr on *Quercus*, Crabbottom, Virginia, 1904 W. A. Murrill 183 Herb New York Botanical Garden, New York

Fructification annual or perennial, i.e. fungus often living through the winter, broadly effused or occurring in interrupted patches and often extending 1 meter or more on log or on dead standing wood, coriaceous, mostly 1-2.5 mm thick (in the form *Poria versipora* f. *radula* up to about 4 mm thick), margin "pinkish buff," fimbriate to cottony, 1-4 mm but mostly less than 2 mm wide, and often becoming fertile, subiculum less than 0.5 mm wide, "pinkish buff", tubes 1-2 mm long, seldom stratified, and if so, rarely in more than two layers, mouths 1-3 to a mm, "cinnamon-buff", dissepiments thin, often becoming somewhat dentate, basidia 2-4-spored, 11-17  $\times$  3-5  $\mu$ ; spores ellipsoidal, 4.5-6 (5  $\times$  3.5) 3-4  $\mu$ , 1-guttulate, hyphae 2-3  $\mu$ , often encrusted, clamp connections minute, no cystidia

The names suggested by Romell (16) for two growth forms of *Poria versipora* are listed for convenience

Forma *deformis* the name used for specimens which exhibit the type of growth caused by the plant's occurring on vertical surfaces

Forma *radula* The name used for specimens which have crenulate or serrulate pore walls (*Poria mucida* var. *radula* Bourd et Galz, *Polyporus radula* Pers. sensu Romell, *Irpez paradoxus* (Schr.) Fr. sensu Bresadola, *Irpez obliquus* (Schr.) Fr. sensu Bresadola, *Irpez deformis* Fr. sensu Bresadola)

**Remarks** — This plant is so variable that it seems unreasonable to propose a new combination of names for a species that has been referred to so much in the literature under the genus *Poria* and for a plant already so overloaded with synonyms and interpretations

Donk (3), however, retains the name *Polyporus*. With reference to the old names, Romell's remarks concerning the different interpretations of this species illustrate the need for adopting some understandable designation. He states:

"Fries' unpublished picture of *Pol. mucidus* is taken from von Post and seems to show *Pol. corticola*. . . Persoon's *Pol.*

*mucidus* (at least the specimens marked 'Obs Myc') is identical with Bresadola's *Poria mollusca*. Bresadola's *Poria mucida* (at least some of the specimens in his herbarium) seems to be *Pol versiporus* Pers. The specimen on *Betula* (no 55 from Eichler) is the resupinate form of Bresadola's *Pol ravidus* [= *Coriolus washingtonensis*]

"Persoon's herbarium contains three specimens with this name [*Polyporus radula*]. One may possibly be a hydroid form of *Polyporus abietinus*. Another recalls *Pol corticola* and *Pol versiporus*. If it is either of these, it can only be the latter, as the hyphae have fibulae [clamps]. The third specimen is also labelled '*Poria radula*' (without hesitation) and has fibulate hyphae. It therefore seems probable to me, that *Pol radula* of Persoon belongs to *Pol versiporus*. Perhaps we come nearest to the truth, if we use the name *Poria radula* for the form of *Poria versipora*, which has crenulate or serrulate pore-walls. Bresadola seems to have placed different species under the name *Poria radula* in his herbarium. Probably none of these, excepting No 3, is referable to *Poria radula* in the sense of Persoon and Fries.

"*Polyporus versiporus*. This is a good species which has nothing to do with *Pol vulgaris* and *Pol vaporarius* though referred by Fries to both. There are several specimens of it in Persoon's herbarium. It is . . . frequent in England . . . and passes there under the name *Poria vaporaria* [probably owing to Fries's references]

"Bresadola seems to use the names *Poria mucida* and *Irpez deformis* for this plant. There is no authentic specimen nor any picture of *Irpez deformis*. But in Fries' herbarium occurs a specimen of *Poria versipora* from Chaillat. Fries has not noted any opinion of it, unless it be this specimen he means in El p 120 and Hym Eur pp 578, 579. If he had recognized his *Irpez deformis* in it, he would have rather mentioned it under that species. Nevertheless, I suspect that *Irpez deformis* is not specifically distinct from *Poria versipora*, and I would propose to use the name '*forma deformis* Fr' for specimens growing on vertical surfaces as these have a somewhat different habit."

Donk (3) agrees that the specific name *versiporus* is the correct one and lists the forms into which Persoon divided his species,

namely (a) *immutatus*, (b) *sistotremoides*, (c) *angulatus*, (d) *deflexus*, (e) *langugosus*, (f) *farinosus*

In the present treatise, however, a broad interpretation is preferred, and the varieties named are restricted to those suggested by Romell

**Allied species** — Because of the great variability of the growth forms of this species, the plant may be mistaken at times for certain species of the genus *Irpex* or *Polyporus* and also of *Radulum*. Poorly developed or short-tubed forms of *Irpex tulipifera* may seem difficult to separate from *Poria versipora*. The spores of the former are cylindric,  $5-6 \times 1-2 \mu$  (Overholts), whereas those of *P. versipora* are ellipsoidal,  $4.5-6 (5 \times 3.5) 3-4 \mu$

Occasionally *Radulum casearum* (Morgan) Lloyd and *R. pallidum* E. & E. have been confused with species of *Poria* and have been sent to me by correspondents for determination. The hymenium of these corky resupinate epixylous plants is warty rather than poroid.

*Poria proxima* Bres. resembles *P. versipora* in color, tube size, and character of pore mouths. The hyphae of both plants may be encrusted. The distinct cystidia in the hymenial layer of *P. proxima* may be used to separate the two plants. Care should be taken not to confuse the encrusted hyphal ends to be seen in sections made of *P. versipora* for typical cystidia.

**Habitat** — *Acacia* sp., *Acer circinatum*, *A. rubrum*, *Alnus incana*, *A. rhombifolia*, *A. rubra*, *A. rugosa*, *A. tenuifolia*, *Betula lutea*, *Carpinus caroliniana*, *Castanea dentata*, *Cedrus arbor*, *Cornus florida*, *Eucalyptus globulus*, *Fagus grandifolia*, *Ilex opaca*, *Juglans cinerea*, *Liquidambar styraciflua*, *Lithocarpus densiflora*, *Magnolia Fraseri*, *M. virginiana*, *Melaleuca incana*, *Nyssa sylvatica*, *Phoenix dactylifera*, *Pinus radiata*, *Populus trichocarpa*, *Prosopis juliflora*, *Prunus serotina*, *Quercus alba*, *Q. densifolia*, *Q. garryana*, *Q. laurifolia*, *Q. marilandica*, *Q. nigra*, *Q. rubra*, *Q. stellata*, *Q. virginiana*, *Ulmus americana*, *Umbellularia californica*, *Vitis* sp.

**Distribution** — British Columbia, Ontario, Alaska, Arizona, Arkansas, California, Connecticut, Delaware, District of Columbia, Florida, Idaho, Illinois, Indiana, Iowa, Kansas, Kentucky, Louisiana, Maine, Maryland, Massachusetts, Michigan, Minnesota, Mississippi, Missouri, Montana, New Jersey, New York, North Carolina, Ohio, Oregon, Pennsylvania, Rhode Island, South

Carolina, Tennessee, Texas, Virginia, Washington, West Virginia, Wisconsin

*Polyporus unitus* Pers , Myc Eur., 2 93 1825

- Polyporus xantholoma* Schw , Trans Am Phil Soc , II, 4 158 1832  
*Polyporus pulchella* Schw , l c (var) Pers , Myc Eur , 2 100 1825  
*Poria pulchella* (Schw ) Cooke, Overholts in Mycologia, 15 219 1923  
*Polyporus medulla-panis*, Bres in Atti Accad Sc Lett , Agati III, 3 84 1897  
*Polyporus medulla-panis*, Bourd et Galz , Hym de Fr , 684 1928  
*Polyporus medulla-panis*, Shope in Ann Mo Bot Gard , 18 398 1931  
*Poria medulla-panis* (Pers) — non *Polyporus medulla-panis* (Jacq) sensu Fr 1821, nec *Poria medulla-panis* (Fr) Sacc 1888  
*Polyporus alabamiae* Berk & Cooke, Berk & Curt (in part), Grevillea, 6 130 1878  
*Polyporus omoema* Berk (probably misprint for "amoena" — in part), Cooke, Grevillea, 15 26 1886  
*Poria tenuis* (Schw ) Cooke (in part), Grevillea, 14 114 1886

Types and important specimens

- Polyporus unitus* Pers Herb of Persoon, Leiden  
*Poria chrysella* Egeland on birch in Seljord, 1912 Herb of Bresadola, Stockholm  
*Polyporus pulchellus* Schw , Bethlehem, Pa Herb of Schweinitz, Herb of the Philadelphia Academy of Science, Philadelphia  
*Poria* (or *Pol* ?) *alabamiae* B & C, on Myrica, Gainesville, Florida Type H W Ravenel Fungi Americani Exsiccati, Herb New York Botanical Garden, New York  
*Physoporus varicolor* Karst on *Alnus incana*, Mustiala Ex Karsten Herb of Bresadola, Stockholm  
*Physoporus vitellinus* on *Alnus*, Mustiala. P A Karsten Herb of Bresadola, Stockholm  
*Poria albo-incarnata* Pat & Gaul Herb Champignons du Haut-Orenoque Par A Gaillard Herb of Bresadola, Stockholm  
*Polyporus xantholoma* Schw , Salem Herb of Schweinitz, Herb Philadelphia Academy of Science, Philadelphia  
*Polyporus alabamiae* B & C Ravenel on *Myrica cerifera*, Gainesville, Florida Herb New York Botanical Garden, New York  
*Polyporus tenuis* (Schw ) Cooke on *Castanea dentata*, Bethlehem, Pa Herb of Schweinitz, Herb Philadelphia Academy of Science, Philadelphia

Fructification annual or perennial, effused for up to 20 cm or more, but usually less, mostly inseparable, up to 8 mm. but usually about 3 mm thick, margin at first sterile, thick, rounded, undulating, tomentose, less than 0.5-1.5 mm wide, "cartridge-buff" to "Saccardo's umber," becoming fertile with age, and in old specimens becoming "snuff-brown"; subiculum white to "cartridge-buff", distinct, up to 1 mm but mostly less than 0.3 mm. thick; tubes 0.5-3 mm. long each season, sometimes stratosed,

but indistinctly stratified; mouths pure white, "buff-yellow," or "ivory-yellow" when fresh, circular, thick-walled, entire, 3-7 to a mm, mostly over 5 to a mm, basidia 4-spored, 3-9  $\times$  15-24  $\mu$ , spores hyaline, smooth, 1-guttulate, subtruncate, ellipsoid to oblong-ellipsoid, 4-7 (4  $\times$  5) 3-6  $\mu$ ; no cystidia, but sometimes paraphysis-like structures 20-25  $\times$  8-11  $\mu$  present, hyphae thin, narrow, frequently encrusted, much branched, 1-2.5  $\mu$  in diameter, without cross walls and clamp connections

*Forms* — This common plant presents a series of growth forms, a fact which, in part at least, accounts for the large number of names attached to the fungus. In color alone the forms may vary from the golden yellow of "*Poria chrysella*" through the egg-yellow of "*Poria pulchella*" to the whitish or snow-white of *Polyporus unitus*. The leathery or corky texture is generally similar in all, but marginal features may differ in the various forms. Characteristic specimens of the "*Pol tenuis*-*Pol alabamae*" forms show broad margins which ramify over the branches, twigs, and leaves of the substratum. Under favorable moisture conditions they may become somewhat rhizomorphic. Usually these forms are softer, more pliable than typical specimens of *Pol unitus*, and do not tend to crack upon drying.

Certain of the forms in the series are so commonly found in the field that for convenience they are designated by name. It is possible to culture some of these under varying conditions of light and to cause them to change color and growth habits. White forms, for example, can be converted into yellow, and yellow plants into those which are entirely white.

### *Polyporus unitus* f. *pulchella*, comb. nov.

Fructificatio siccitate saepe rimosa, porae nondum siccae  $\frac{1}{2}$ - $\frac{1}{2}$  mm diam., plus minusve pallide ochraceo-luteae; margo crassus, rotundatus, haud latus, sterilis vel subiculosus vel rhizomorphus, sporae 4-7  $\times$  3-6  $\mu$ , saepissime 4  $\times$  5  $\mu$ ; hyphae ramosissimae. Fructificatio often checking upon drying, pore mouths 5-6 to a mm, "buff-yellow," "ivory-yellow," and other yellow shades when fresh; margins thick, rounded, and not broad, sterile, or appear-

<sup>1</sup> *Pol unitus tenuis* is often "ivory-yellow" (a very pale yellow), but this frequently shades into "pinkish buff." The bright yellows rather than the buffs are more characteristic of *P unitus pulchellus*.

ing in sheets of mycelium (subiculose), or rhizomorphic, spores 4-7 ( $4 \times 5$ ) 3-6  $\mu$ , hyphae much branched

This form is distributed widely throughout the continent and occurs so commonly in the West that collections from there were at one time kept separate from those made in the East. The records of its occurrence by region show that it cannot be considered more prevalent in the West than elsewhere.

The name applies to all those forms which are bright yellow, orange-yellow, and egg-yellow. Plants which have been named *Poria chrysella* are also grouped here.

Physiologically, many of the yellow plants are identical with those which are white. Cultures made from strictly white forms exhibit yellows, and yellow plants become white when light conditions are altered.

**Cultures** — Isolated from *Populus balsamifera* on Burnt Island, Great Slave Lake, Northwest Territories, and from *Populus tremuloides* at Selkirk, Yukon Territory. Both fungi grow more rapidly in the dark than in the light, and the cultures of both vary from white to yellow. The fungus from the Northwest Territories belongs to the "rapid-growth" group of resupinate polypores and falls into both the "large-range" and "high-temperature" categories. The "ivory-yellow" or "colonial buff" mycelium exhibits a concentric-ring to radiating type of growth in cultures kept in the light for fourteen days. Mycelium cultured in the dark is white to "Marguerite yellow." Pore formation appeared in some of the cultures within this period, whether they had been kept in the light or the dark. No pores were formed in cultures of the same age of the plant obtained from the Yukon Territory.

Like and different features of forms of the resupinate polypores are often more apparent if the fungi are grown under adverse conditions or at least upon substrata ordinarily foreign to them. Both the yellow and the white forms of *Polyporus unius* (the two plants occur on frondose woods in nature) produce less mycelial covering on white-pine than on hardwood test pieces in one-year-old cultures. Isolates of neither the *pulchella* form nor the white form of *Pol. unius*, referred to as *medulla-panis*, mask the wood unless a hardwood block is placed in the same flask. Even in such cultures the coniferous block is not always covered.

Both forms are white and exhibit a more or less arachnoid mycelial growth on the coniferous wood in contrast to the thick chamois-like covering in red-gum block cultures. Pore formation appears on both red-gum and white-pine blocks in *medulla-panis* cultures, but no pores occur on either the hardwood or the coniferous blocks in one-year-old cultures of the *pulchella* form.

The one-year-old cultures of the *medulla-panis* form on white pine are noteworthy since the pores make up a more conspicuous part of the culture than the arachnoid mycelium. The cultures on coniferous wood exhibit a fructification which immediately suggests that of *Poria xantha*, or *P. xantha* f. *crassa*, found so commonly on conifer-wood structures in weave and textile sheds and in other buildings habitually wet. Macroscopically the fructifications appear to be duplicates of those of *P. xantha* and *P. xantha* f. *crassa* which often occur on large fallen western conifers and other woods. *P. xantha* and *P. xantha* f. *crassa* are common on beams, girders, and other timbers in retail lumber and mill yards, especially in the Northwest and in certain other regions. Both whitish and very pale yellow fructifications of these fungi occur in nature and in culture. *P. xantha*, furthermore, appears on both hardwoods and conifers in arctic regions. I have found it common on both spruce and willow in the lower Mackenzie River districts.

Spore measurements are reliable features to separate the yellow forms of *Polyporus unitus* and *Poria xantha* should environmental conditions favor the growth of the frondose plants on coniferous wood in nature and so lead to difficulty in distinguishing them from the usually conifer-inhabiting plant *P. xantha*.

The spores of both *Poria xantha* and *P. xantha* f. *crassa* are  $1-1.5 \times 4-6 \mu$ , those of *Polyporus unitus*,  $3-6 (4 \times 5) 4-7 \mu$ .

### ***Polyporus unitus* f. *tenuis*, comb. nov. \***

Fructificatio siccitate plerumque non rimosa, porae  $\frac{1}{4}$ – $\frac{1}{2}$  mm diam, pallidissime ochraceo-luteae, rubidiuscule ochraceae vel pallide cinnamomeae, margo latus, sterilis, tomentosus, saepe subiculosus, interdum rhizomorphus; sporae  $3-4.5 \times 3-5 \mu$ , plerumque  $3 \times 4.5 \mu$ , hyphae ramosissimae.

Fructification uncommonly checking upon drying, pore mouths 4–5



to a mm, "ivory-yellow," "pinkish buff" to "cinnamon-buff", margins broad, sterile, tomentose, often forming sheets of mycelium (subiculose), and sometimes rhizomorphic, spores 3-4 5 ( $3 \times 4.5$ ) 3-5  $\mu$ , hyphae much branched

Characteristic specimens of this plant are more "pliable" than those of *Polyporus unius* or of the *pulchella* form. Although widely distributed in regions east of the Mississippi River and particularly common in the northern region of the Great Lakes, New England, the southern Appalachians, and the South Central part of the eastern United States, the plant is more restricted in its occurrence than is *Pol unius* or *Pol unius* f *pulchella*. In general, it is not a western plant.

**Cultures** — Isolated from chestnut, Great Falls, Virginia. Cultures of this fungus are predominately white for at least six months. Small strands of mycelium or rhizomorphs are distinctive and appear on the inoculum in cultures of this form, but have not been noticed in ones of *Polyporus unius*. *Pol unius* fruits in the diffuse light of the laboratory, but cultures of the variety *tenuis* grown under similar conditions have not shown any indication of hymenophore formation.

**Allied species** — Reference has been made in the literature to specimens in the series which resemble *Poria subacida* Pk. The tubes of *P subacida* are generally longer and the dissepiments thinner than those of *Polyporus unius*. The usually narrow and much-branched hyphae of the latter are distinctive.

Macroscopically, forms of *Polyporus unius* may suggest *Poria ferox* since the colors "cartridge-buff," "pinkish buff," and "cinnamon-buff" are sometimes common to both. The hyphae are seldom branched in *P ferox*. Decay in the frondose woods attacked by *Pol unius* is not cubical, and the mycelium does not form sheets or mats in the rotten wood. *P ferox* is known only on conifers; it does not cause a white rot. Sheets of mycelium form in the decayed wood (Plate IV).

Specimens of *Poria albo-incarnata* Pat. suggest *Polyporus unius* macroscopically, and the spores of the two plants may be similar in size. Unlike *Pol unius*, *P albo-incarnata* turns scarlet red when KOH is applied.

**Habitat** (of the species and its forms) — *Acer rubrum*, *A saccharinum*, *Alnus* sp., *Arbutus californica*, *A halopensis*, *Artemisia californica*,

*Betula occidentalis*, *B. papyrifera*, *Carya ovata*, *Castanea dentata*, *Ceanothus thyrsiflorus*, *Cornus florida*, *Fagus grandifolia*, *Fraxinus nigra*, *Gleditsia triacanthos*, *Gymnocladus dioica*, *Hamamelis virginiana*, *Juglans nigra*, *Liriodendron tulipifera*, *Myrica cerifera*, *Parthenium argentatum*, *Populus balsamifera*, *P. tremuloides*, *P. trichocarpa*, *Prunus persica*, *P. serotina*, *Quercus alba*, *Q. borealis maxima*, *Q. lobata*, *Q. prinus*, *Q. utahensis*, *Q. velutina*, *Q. virginiana*, *Rhus toxicodendron*, *Robinia pseudoacacia*, *Salix nigra*, *Tilia glabra*, *Ulmus americana*

*Distribution* (of the species and its forms) — Manitoba, Northwest Territories, Ontario, Quebec, Yukon Territory, Alabama, Arizona, Arkansas, California, Colorado, Connecticut, Delaware, Florida, Georgia, Idaho, Illinois, Indiana, Iowa, Kansas, Kentucky, Louisiana, Maine, Maryland, Massachusetts, Michigan, Minnesota, Mississippi, Missouri, Montana, Nebraska, New Hampshire, New Jersey, New Mexico, New York, North Carolina, Ohio, Oregon, Pennsylvania, Rhode Island, South Carolina, South Dakota, Tennessee, Texas, Utah, Vermont, Virginia, Washington, West Virginia, Wisconsin

*Trameles Trogu* Berk., Mitth. Schw. Naturf.  
Ges., 2 52 1850

*Trametes Trogu* Berk., Konrad and Maublanc, Icones selectae fungorum, 1 444 1924-30

*Trameles hispida* subsp. *T. Trogu* (Berk.) Bourd. et Galz., Bull. Soc. Myc. Fr., 41 163 1925

*Fructification* sessile or semiresupinate, usually small but sometimes up to 15 cm long, 0.5-10.5 × 3-15 × 0.5-2 cm, surface densely ochraceous to tawny, pubescent, weathering gray and becoming fibrous; context whitish, "cartridge-buff," or "cream-buff", tubes mostly 2-10 mm long, mouths 1-2 to a mm, spores cylindrical, hyaline, 7-11.5 × 2.5-3.5, hyphae hyaline, aseptate, 2-6 μ in diameter

*Allied species* — This species is closely related to *Trametes hispida*. Both plants occur usually on willow, aspen, or poplar. It is possible to separate the two plants by the color of the context, which is whitish or at least not dark brown in *T. Trogu*, but is dark brown in *T. hispida*. The pileus is not ordinarily so conspicuously hirsute in *T. Trogu* as in *T. hispida*. Both plants may

be semiresupinate, but *T. Trogu* occurs in that state more frequently.

*Habitat* — *Aesculus californica*, *Populus tremuloides*, *Quercus macrocarpa*, and *Salix* sp., also occurs on *Fomes fomentarius*

*Distribution* — Ontario, Alaska, California, Connecticut, Nebraska, New Hampshire, Pennsylvania, Vermont

*Trametes malicola* Berk & Curt., Journ. Acad.

Phila., 209 1856

**Important specimen**

*Trametes malicola* Berk on *Pyrus malus*, Kentucky C G Lloyd 07665 Herb of Bresadola, Stockholm

Fructification effused, reflexed, or entirely resupinate; pileus 1-10.5 × 0-1 × 0.4-2 cm, glabrous or nearly so, "cartridge-buff" to "warm buff", context "pinkish buff," 1-5 mm thick, tubes 1.5-5 mm long, mouths concolorous with the context, round to angular, mostly 2 to a mm, basidia 12-15 × 4  $\mu$ , spores cylindric, 8-12 × 3.5-4  $\mu$ , hyphae occasionally branched, 2.5-4.5  $\mu$

*Allied species* — *Trametes malicola* is sometimes confused with *T. sepium*. The context of *T. malicola* is light brown or wood-colored, while that of *T. sepium* is whitish or not truly brown

*Cultures* — Isolated from *Populus grandidentata*, Ann Arbor, Mich. This fungus, which is found only on hardwoods in nature, grows readily on hardwood blocks in culture and first covers them with a white mycelial growth which within a year becomes "pinkish buff" to "cinnamon-buff". No pores are formed. The mycelium does not grow readily on conifers and after one year in culture on white-pine blocks only covers less than one fourth of the block faces. It is noteworthy, however, that the pine is stained a conspicuous bright red for a distance of at least one half inch beyond any outward visible mycelium — a condition which suggests the early stages of red rot caused in pine by *Fomes pinis*. The "avellaneous" or "pinkish cinnamon" color of the pine blocks turns "Nopal red" in advance of the mycelium in such cultures.

Cultures of *Trametes malicola* make their best growth in the dark. This plant belongs to the "slow-growth" group of *Porias* and in the "large-range" temperature group. It has been placed in the "average temperature" class for best growth.

*Habitat*. — *Acer negundo*, *A. rubrum*, *A. saccharinum*, *A. saccharum*,

*A. spicatum*, *Ailanthus* sp., *Benzoin aestivale*, *Carya alba*, *C. glabra*, *C. lacmosa*, *C. ovata*, *Populus tremuloides*, *Malus pumila*, *Rhus vernix*, *Tilia glabra*

**Distribution** — British Columbia, Ontario, Alabama, Connecticut, District of Columbia, Indiana, Iowa, Kentucky, Louisiana, Maine, Michigan, Minnesota, Missouri, Nebraska, New Hampshire, New Jersey, New York, Ohio, Oklahoma, Pennsylvania, Tennessee, Vermont, West Virginia, Wisconsin, Wyoming

**Occurrence** — *Trametes malicola* is most commonly found on *Malus pumila* and *Acer rubrum*

*Poria canescens* Karst., Rev Myc., 10. 1887

(Plate V, Figs 1-2)

**Important specimen**

*Physisporus canescens* Karst. on *Alnus incana*, Mustiala, ex Karst., Herb. of Bresadola, Stockholm

**Fructification** annual, effused in irregular patches for as much as, but usually less than, 25 cm, about 3 mm thick, margin fimbriate, whitish up to 5 mm wide, but mostly much less, subiculum 0.5 mm thick, often disappearing in old plants, tubes 1-3 mm long, mouths 4-5, mostly 4 to a mm, when fresh white to "light drab" to "drab gray," turning "army-brown" to "Natal brown" upon bruising; basidia 7-14 × 3-7  $\mu$ , 4-spored; spores hyaline, allantoid-reniform, 4-6 × 2-3  $\mu$ , hyphae hyaline, mostly non-septate, 2-3  $\mu$  in diameter

**Allied species.** — Some collections of this species labeled *Poria cinerea* Schw. are deposited in various herbaria. Since no specimens of *P. cinerea* exist either in the Schweinitz herbarium or in the Michener collection in Washington, it is difficult to interpret the Schweinitz plant. The description may fit several plants which are ashy in color. *P. cinerea* was reported on *Larodendron*, and this is a wood on which *P. canescens* frequently occurs.

Bresadola was of the opinion that *Poria canescens* was closely related to *Polyporus subspadicea* Fr. A plant labeled *Pol. subspadicea* in the Bresadola herbarium in Stockholm suggests *Pol. adustus* macroscopically, but the spores are given as 7-9 × 3.5-4  $\mu$ . The spores of *Pol. adustus* are smaller both in length and width. The European interpretation of *Pol. subspadicea*

is so varied that it is doubtful if this plant can be accurately compared with *P. canescens*

*Poria canescens* has also been labeled *P. salmonicolor* Berk & Curt Many distinct species which turn red or brown-red upon bruising or drying have been placed under this name The specimen of *P. salmonicolor* Berk & Curt marked "type" in the herbarium of Berkley, 1879, at Kew is actually *P. spissa*

Immature and resupinate specimens of *Trametes Trogu* and *T. mollis* (Somm) Fr suggest *Poria canescens*, but the size of the pore mouths can be used as a basis for distinguishing these plants The pore mouths of *T. Trogu* and *T. mollis* (Somm) Fr are mostly 3 or less than 3 to a mm, whereas those of *P. canescens* are 4-5 to a mm

*Habitat* — *Acer rubrum*, *Carya* sp, *Fagus grandifolia*, *Liquidambar styraciflua*, *Liriodendron tulipifera*, *Populus tremuloides*, *Ulmus americana*

*Distribution* — Ontario, Yukon Territory, Connecticut, District of Columbia, Georgia, Indiana, Louisiana, Maryland, Michigan, North Carolina, Ohio, Vermont, Virginia, Washington, West Virginia

*Poria fimbriatella* (Peck) Sacc, Syll. Fung., 6 303 1888

*Polyporus (Physisporus) fimbriatellus* Peck, N Y State Mus Rep, 38 91 1885

(Plate VI)

Type

*Polyporus fimbriatellus* on maple, Osceola. Type C H Peck New York State Museum, Albany

Fructification annual, effused up to 1 meter, but usually only 3-10 cm long and mostly not over 6 cm broad, separable, margin white, usually 1-2 mm wide, tomentose, somewhat fimbriate and often with conspicuous white rhizomorphs, subiculum whitish or "pale pinkish buff," up to 0.3 mm thick; tubes 1-2 mm long, mouths "vinaceous buff" to "avellaneous," 4-5, mostly 4, to a mm; spores smooth, hyaline, ellipsoidal,  $2.5-3.5 \times 1.5-2 \mu$ ; encrusted cystidia present, hyphae somewhat branched, 2-3  $\mu$  in diameter, no clamp connections

*Allied species* — Because the names suggest similar types of growth, *Poria fimbriatella* and *P. myceliosa* may be confused Furthermore, the spores of the two plants are very nearly alike. *P. fim-*

*briatella* differs from *P. myceliosa* in the presence of encrusted cystidia and in the absence of clamp connections.

*Habitat* — *Alnus tenuifolia*, *Populus balsamifera*, *P. tremuloides*, *P. trichocarpa*, *Quercus Kelloggii*

*Distribution* — Northwest Territories, Yukon Territory, California, New York

*Poria incrassata* (Berk. & Curt.) Burt, Ann. Mo. Bot Gard., 4 360 1917

*Merulius incrassatus* Berk. & Curt., Hooker's Lon Journ Bot., 1 234 1849

*Merulius spissus*, Berk., Grevillea, 1 70 1872

*Polyporus pineus* Peck, N Y State Mus Rep., 41 78 1888

*Poria pinea* Peck in Sacc., Syll Fung., 9 194 1891

(Plates VII-XI)

Important specimen

*Poria pinea* on pine bark, Selkirk, New York Type Ex Herb New York State, Herb Mo Bot Garden

Fructification annual, resupinate, on stored lumber and on timbers in buildings, with the mycelium sometimes extending from basement floors up to the third story, drying brittle and often breaking up and falling from the substratum, margin extending out in broad, fanlike structures commonly 120 mm wide, whitish when young, tinged with yellowish olive, and turning to brown or black in age, whitish rhizomorphs often developing and, when mature, becoming yellowish, turning to brown or black, frequently appearing as heavy rootlike or vinelike growths, fructification when developed in the open often with a thick whitish subiculum which cracks upon drying, tubes not stratified, up to 10 mm in length, mostly 3-7 mm, mouths 1-3 to a mm., spores fuscous or dusky olive when mature,  $5.5-7 \times 8-12 \mu$ , cystidia not present, hyphae smooth, often branched, varying from 1.1-5.5  $\mu$  in diameter

*Allied species* — Fructifications of this plant are not difficult to identify, but frequently one finds only the mycelial growth in the storage sheds, mill yards, and buildings. The mycelium has often been mistaken for that of species of *Merulius* and of other genera of fungi. Fruiting bodies may develop several feet away from the portions of mycelial growth that cover the wood more conspicuously

*Cultures*. — Isolated from "yellow pine," obtained from the United

States Forest Products Laboratory Young cultures of *Poria incrassata* are white The mycelium exhibits at first a concentric-ring growth which finally extends out in radiating strands or fans These turn from white to "chamois" or "amber-yellow" to "Isabella color" The best growth takes place at temperatures ranging from 23° to 30° C, and the species is classified in the "average-temperature" group<sup>4</sup> The rate of growth in the dark is almost twice as great as that in the light In two-week-old cultures the mycelium grown in the dark is white, whereas that exposed to the light varies from white to "pinard yellow"

*Poria incrassata* has been cultured on a great variety of substances Humphrey (7) grew the fungus on representative species of thirteen genera of conifers and twenty-five genera of broadleaf woods Approximately one half of the test blocks were so thoroughly decayed at the end of two years that the wood (when dry) could be readily pulverized between the fingers

Since *Poria incrassata* is considered one of the chief causes of rot in building timbers, much effort has been made to select chemicals which are toxic to the growth of the fungus and which may be used as both desirable and serviceable preventives The fungus has been cultured on a great variety of substrata containing toxic chemicals and has been found extremely susceptible to many of them (4) Richards (13) concluded that this fungus was the least resistant of a number of wood-rotting organisms to sodium fluoride Included were such fungi as *Polystictus abietinus*, *Pol versicolor*, *Lentinus lepideus*, *Stereum fasciatum*, and others

Ethyl mercury chloride mixtures and ethyl mercury phosphate mixtures, among others, have shown a high degree of fungicidal efficiency Nonmercurials (many of them exhibiting at least a fair degree or better of toxicity) such as chloroorthophenyl-phenol, sodium tetrachlorophenolate, and butyl phenol have been used The inhibiting effects of chemicals other than the

<sup>4</sup> Humphrey and Siggers' (9) classification is based upon temperatures ranging between 24° and 32° C Thirty degrees centigrade has been used as a basis for separation of the groups in the present series of papers. Since *Poria incrassata* grows well at 30°, the fungus might be placed in a higher temperature category It can be seen, however, that the intermediate (or average) class more nearly expresses the best temperatures for growth, since development is retarded at higher temperatures and since the best growth takes place at those from 23° to 30° C

benzene derivatives have been tested too. Aniline copper fluoride, copper acid fluoride, aniline copper sulphate, fluorsit, thanalith, and ammonium arsenous trioxide are only a few of those tried. Some of these chemicals, and others, such as the creosotes, are toxic to *Poria incrassata*, but are of chief value for use as fungicides where discoloration of the lumber and other factors do not have to be considered (4).

*Habitat* — *Pseudotsuga taxifolia*, *Pinus palustris*, *P. ponderosa*, *Quercus borealis maxima*, *Sequoia sempervirens*, *Taxodium distichum*

*Distribution* — Ontario, Alabama, California, District of Columbia, Florida, Georgia, Idaho, Illinois, Kentucky, Louisiana, Michigan, Mississippi, Nebraska, New York, Oklahoma, Oregon, Pennsylvania, South Carolina, Tennessee, Texas, Virginia, Washington

*Occurrence* — The fungus does not occur in the forest,<sup>5</sup> but appears in buildings and stacked lumber. Although in this paper, because of the lack of specific records, comparatively few woods are listed as its habitat, the fungus will, actually, attack any of the commercial species. It is especially common in the South and in the Northwest in buildings where there is a heavy condensation of moisture in walls and between floors and subfloors. Lumber shipments, it is believed, are frequently responsible for its appearance in other localities. The fungus often spreads in the joists and baseboards, and up in door and window frames. Instances have been reported where it has destroyed the timber in the second story of structures and has progressed to the third story.

Although, according to Humphrey (8), the great losses through decay are sustained in those structures where the air is humidified, either by artificial means or through manufacturing processes such as are used in weave and dye sheds in the textile industry and in paper mills, *Poria incrassata* is not the agent of decay in such conditions. It does occur frequently in buildings where moisture is not excessive.

In the South many outbreaks have occurred in lumber yards

<sup>5</sup> Humphrey (7) reports that he found it once on a charred cedar trunk along the roadside at Shelton, Washington, and that earlier investigators had reported it a very few times on stumps or fallen timber in New York and South Carolina. The destruction of a house by *Poria incrassata* is illustrated graphically by Richards (13). "The foundation was fair, but the joists were allowed to rest on a stump which furnished entry for the fungus."



and the fungus is widely distributed through residences and buildings of various types. I have seen it running up concrete posts and progressing through wooden flooring four feet or more from the ground into piles of kiln-dried lumber stacked in dry sheds. Resawing of several thousand feet of this lumber was necessary to salvage that which was still merchantable. The fungus was found also in the open yard. *Poria incrassata* is prevalent on all the chief structural materials used in buildings in the South and West. Hardwood flooring, nail kegs, and oak crating also have been attacked (8). The fungus does occur in the North, but chiefly, however, as the result of shipping lumber in from the South or West. It has been seen in Chicago and Detroit in buildings and lumber.

**Decay** — *Poria incrassata* produces a dry rot and causes the wood to check into cubes. In the final stages of decay the rotted timber can be easily crushed to a powder between the fingers.

The fungus itself appears in papery, often fan-shaped, sheets of mycelium, which may form between flooring, frequently spreading upward between the walls. In advanced stages of decay shrinkage cracks appear in the wood. Chief characteristics of use in diagnosing *Poria incrassata* in wood have been summarized by Hubert (6) and listed as (a) brown rot, (b) zone lines, (c) large bore holes, spiral cracks, (d) unconstricted old hyphae.

It has frequently been emphasized that fungi and termites are associated in their destruction of wood and it has often been assumed that *Poria incrassata* is one of the common species of the wood-rotting agents involved. Much damage caused by fungi has been attributed to termites and likewise much loss due to termites has been ascribed to fungi. Observations made in the South, at least, point to the fact that the insect and *P. incrassata* may not live together so closely as is often believed. The environment may be favorable for either one, but if the termite destroys the wood first, conditions may not be so favorable for the fungus. It appears likely that decayed wood, furthermore, is not the most suitable food for the insect. At any rate, the majority of specimens of wood I have collected from buildings decayed by *P. incrassata* do not show termite damage, although the insect could be working in the same structure. Termite tunnels were present, however, on planks exhibiting mycelium of the

fungus in the house shown in Plates VIII–XI. This house is typical of many buildings which are so constructed as to favor fungous development and which have been damaged by *P. incrassata*, for in one foundation wall burlap closes the only ventilator, and, since the house has no basement, brick supporting walls beneath the floors form small rooms that prevent circulation of air. The top of a tile drain beneath the structure is broken and permits evaporation of standing water. Furthermore, a sidewalk on the opposite side of the house lies a few inches below yard level, so that during heavy storms it forms a trough for the rain, which drains beneath the building through a large crack in the stucco wall.

Additional information on the relation of termite activity and rot fungi is greatly needed. It is of interest that Hendee (5) found comparatively few basidiomycetes in association with termites. Two hundred and fifty-eight fungous cultures were made from fifteen colonies of *Kaloterms minor* Hagen, one hundred and twenty from twelve colonies of *Reticulitermes hesperus* Banks, and twelve cultures from twelve colonies of *Zootermopsis angusticollis* Hagen. The colonies were collected in various localities and occurred in at least eleven species of wood. Isolations were made not only from the termites themselves, but also from their fecal pellets, loose detritus or frass within their burrows, and the wood of the walls of the burrows. Since spores were not produced by the basidiomycetes, the fungi in this group were not easily identified, but only six of the twenty nonsporulating cultures of fungi isolated were recognized as being basidiomycetes (5).

*Poria nigra* Berk. in Hooker's Lon. Journ. Bot.,  
4 304, 1845

*Polyporus niger* Berk., Hooker's Lon. Journ. Bot., 4 304 1845.

*Melanoporia nigra* (Berk.) Murr., North American Flora, 9 15 1907

*Poria niger*, Grevillea, 53 (1872) 3

(Plate XII)

Type, cotype, and important specimen

*Poria niger* Berk., Ohio. Type Herb Berk., Kew Gardens, London

*Poria nigra* B & Br., Ohio. "Type" Herb New York Botanical Garden,  
New York.

*Polyporus niger* Berk., Cincinnati, Ohio A P & L V Morgan ex herb Calkins  
1890 Herb New York Botanical Garden, New York

Fructification effused for 14 cm or more, woody, inseparable, up to 2 cm thick, margin sterile, pubescent, "warm sepia," up to 2 mm. wide, becoming black, old tube layers and subiculum forming a horny black layer next to substratum, often with a metallic luster, tubes stratified, uneven, up to 5-7 mm long each season, mouths "hair-brown," "warm sepia," 4-7, mostly 6, to a mm, regular, edges entire, basidia 8-8.5  $\times$  3-4.5  $\mu$ ; spores hyaline or pale ferruginous 3  $\times$  3  $\mu$  (?), hyphae both light and dark brown, sometimes arranged together so that dark brown hyphae resemble conducting organs, brittle, rarely septate, 2-7  $\mu$  in diameter, no clamp connections (but appearing in submerged mycelium in cultures), cystidia none or appearing as dark brown blunt hyphal pegs (rarely sharpened), 11-15  $\times$  4-7  $\mu$

*Allied species* — *Poria nigra* may call to mind an old, weathered and dead, abortive fruiting body of a species of *Fomes* (*F. Everhartii* for example) or one of the brown resupinates of the *Fomitiporia* or *Fomitiporella* group. The very dark chocolate-brown or black fruiting structure of *P. nigra* might, furthermore, suggest that carbon from the burned log or fire scar from which it was growing had discolored the polypore. The dark color is, however, characteristic of the fungus itself. Plate XII shows a specimen which actually has an ungulate form and so resembles a species of *Fomes* more strikingly than is usual for *P. nigra*.

*Fomitiporia cubensis* blackens in age and closely resembles *Poria nigra*. The ashy-white character of the pore mouths of this Cuban plant and its tubes stuffed with whitish mycelium are distinctive, however, for the species.

Both *Poria nigra* and *P. megaloporia* Pers. are found on oak. *P. megaloporia* is apt to occur on structural woods as well as in the forest, whereas *P. nigra* is a fungus of the woods. The fructification of *P. megaloporia* is gray-brown, i.e. "drab," "snuff-brown," or "Saccardo's umber" rather than the darker browns of *P. nigra* ("hair-brown," "warm sepia," or blackish). A felty subiculum, as in *Fomes nigrolimitatus*, is often present in *P. megaloporia*, but it does not appear in *P. nigra*. The felty nature of the border of *P. megaloporia* may be used to separate the two plants.

**Cultures** — Isolated from *Quercus velutina* from Hardin, Illinois, obtained by Ross Davidson and W A Campbell, Division of Forest Pathology, Washington, D C Although in culture, isolates of *Poria nigra* vary in color and other characteristics, its mycelium remains white for a much longer period than does that of any of the brown resupinates, with the possible exception of *P ferrugineo-fusca* (on Douglas fir from Oregon) Save for the fruiting surfaces, which in this isolate of *P nigra* are mostly "light mouse-gray" or "mouse-gray" in one- and two-year-old cultures, the colors of the mycelium of the two plants are similar *P ferrugineo-fusca*, from a conifer, covers red-gum blocks in one-year-old cultures with fully as luxuriant a growth of mycelium as it forms in cultures on white-pine blocks *P nigra*, on the other hand, forms only a thin sheet of mycelial growth over parts of white-pine test blocks This fungus completely masks red-gum blocks with a thick layer of mycelium in one-year-old cultures The "mouse-gray" fruiting surfaces of "*P nigra*" should readily distinguish it from *P ferrugineo-fusca*

**Habitat** — *Quercus alba*, *Q borealis maxima*, *Q coccinea*, *Q velutina*

**Distribution** — Florida, Illinois, Iowa, Michigan, Missouri, North Carolina, Ohio, Pennsylvania, South Carolina, West Virginia, Wisconsin

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*Trametes Morgani* Lloyd on *Quercus* sp., Bland, Virginia





*Trametes serpens* Fr. Type, Stockholm, Sweden





BAXTER

PLATE III



*Trameetes serpens* Fr on *Nyssa aquatica*, Natchez, Mississippi





Decay caused by *Poria ferox*, sp. nov., in *Juniperus virginiana*





FIG. 1 *Poria (Pol) canescens* Karst on beech, Marquette National Forest, Michigan  
Coll and det D. V. Baxter



FIG. 2 *Poria canescens* Karst on *Alnus incana*, Mustula, Finland, 1886





*Poria fimbriatella* (Pl.) Sacc on *Quercus Killoggi*, Placerville, California







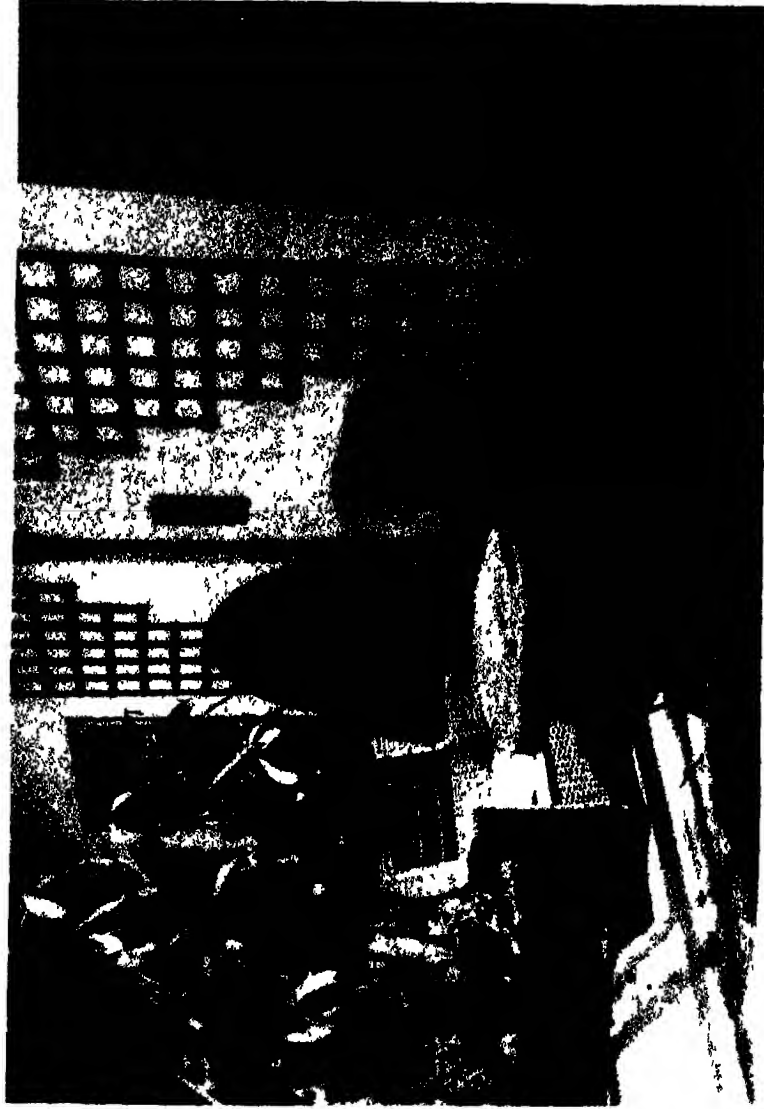
*Poria merassada* Murr on planks of *Pinus palustris*, from the foundations of the old income-tax building, Washington, D C





A stucco house in Oklahoma which is badly damaged by *Porra incrassata*  
The foundations are inadequately provided with ventilators





Patio of house shown in Plate VIII    Moisture from plant culture, with that arising in stucco walls from foundations beneath is sufficient for the rapid growth of *Persea incarnasada*



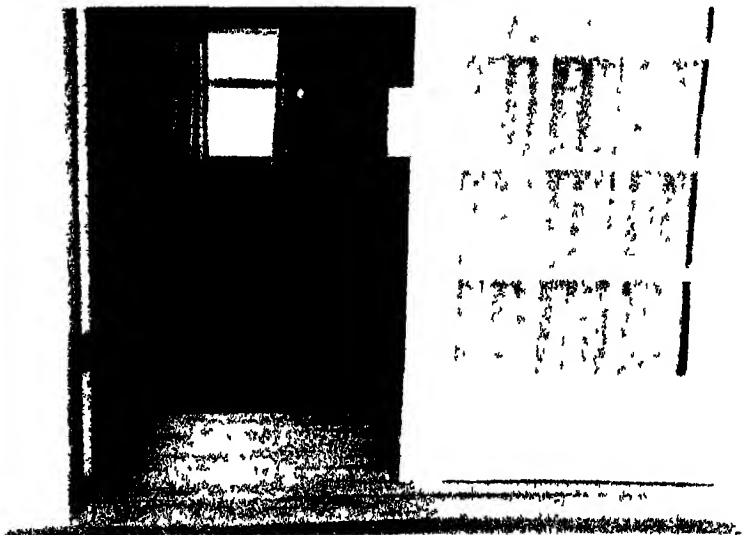


FIG. 1 Infested hardwood floors of room adjacent to the patio of the house shown in Plates VIII and IX. The floors are greatly weakened and the wood badly decayed by *Poria incrassata*, especially at the point of contact of the stucco walls of the patio, the sills, and the joists beneath.



FIG. 2 Badly decayed sill and joists beneath the hardwood flooring shown above.







FIG 1 Untreated timber used in 'repairing' the damage caused by *Poria incrassata* and in supporting the infested joists of the stucco home. The wooden prop rests on the damp ground beneath the house

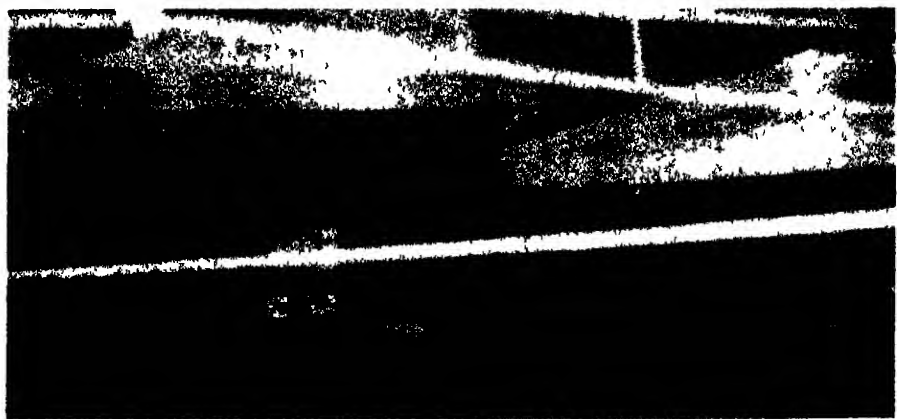
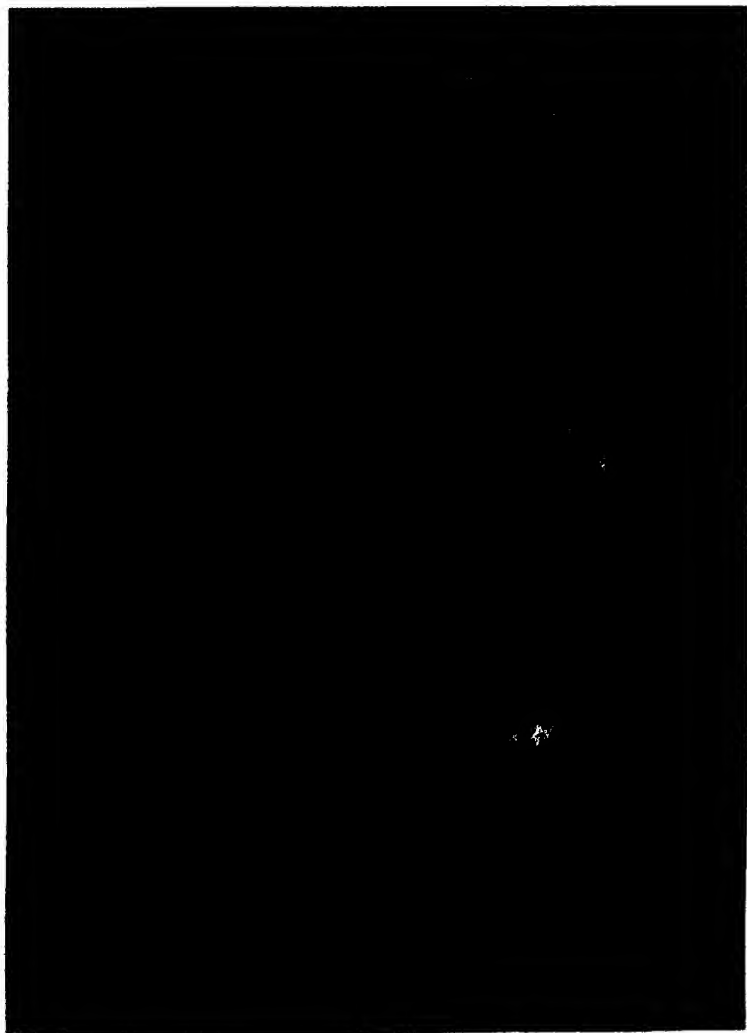


FIG 2 Large supporting beam beneath the house, decayed by *Poria incrassata*. The timber used in the "repair" which props up the house is untreated. The rotten wood from parts of the old structure is left in the ground





*Porus nigra* Berk on *Quercus velutina*, Ann Arbor, Michigan



# FROST HEAVING OF FOREST PLANTING STOCK AT THE KELLOGG REFOR- ESTATION TRACT, NEAR BATTLE CREEK, MICHIGAN

MERRILL E DETERS

**F**ROST heaving is a factor which in many regions limits the planting of forest tree stock in the fall. It occurs particularly in localities characterized by open winters and frequent periods of freezing and thawing weather. Other factors such as soil texture, aspect, drainage, and density of ground cover may markedly affect it.

In southern Michigan frost heaving may be so damaging that fall planting can be done only with much risk. Westveld and Van Camp<sup>1</sup> state that such planting is possible in Michigan north of a line from Bay City to Ludington because this region usually has a continuous winter snow cover which protects the trees against heaving. Where it can be practiced, fall planting offers the advantage of a greatly lengthened annual planting period and of many days of ideal planting weather.

The Department of Forestry of Michigan State College conducted fall planting at its Kellogg reforestation tract in the northeastern part of Kalamazoo County, near Battle Creek, Michigan, during the years 1931, 1936, and 1937. Results from experiments conducted there and from certain other tests make it possible to evaluate frost heaving in southern Michigan and also to suggest means whereby the risk of fall planting may be greatly lessened.

## THE TRACT

The Kellogg tract is typical of reforestation sites in southern Michigan. It is made up of rough, eroded farm land which has been abandoned. The old fields have a cover of blue grass and the various weeds characteristic of old-field sites.

<sup>1</sup> Westveld, R. H., and Van Camp, J. L., *Forest Planting on Michigan Farms* Michigan State College of Agriculture and Applied Science, Extension Bulletin 147, 1935

## FROST-HEAVING DAMAGE IN 1931-32

Data on mortality due to frost heaving in plantations made in the fall of 1931 were collected by R H Westveld and B M Kirk, formerly of the Forestry Department, Michigan State College. They are given in Table I. Each of the mortality percentage values is based on samples of one hundred or two hundred trees.

TABLE I  
MORTALITY PERCENTAGES DUE TO FROST HEAVING DURING THE  
WINTER OF 1931-32

Species	Class of stock	Site preparation	Planting method	Mortality percentage
White pine	3-0		Shovel (hole) Shovel (slit)	60
	2-1			23
	2-2			12
	3-0			65
	3-0			55
Red pine		Furrowed		43
		None		20
		Furrowed (mulched)		10
		None (mulched)		5
Average mortality				32.6

During the winter of 1931-32 mortality averaged 32.6 per cent, with a maximum of 65 per cent and a minimum of 5 per cent. The data also show the various classes of stock affected. The mortality of stock of 3-0 class averaged 60 per cent as compared with 23 per cent for 2-1 stock and 12 per cent for 2-2 stock.

Site preparation and mulching also bring about significant differences. On furrowed areas 43 per cent of the trees were killed as compared with 20 per cent on unprepared ground. Mulching with straw gave best results, with losses of only 5 and 10 per cent on untreated and furrowed sites respectively.

## FROST-HEAVING DAMAGE IN 1936-37

Data on damage during 1936-37 were collected from nineteen sample plots of one hundred trees each. They are given in Table II. Trees are here classified as "heaved," "partly heaved," and "not heaved." Heaved stock is that which was forced completely

TABLE II  
FROST HEAVING OF FALL-PLANTED STOCK DURING THE  
WINTER OF 1936-37

Species	Age of stock	Site preparation	Aspect	Heaving percentage		
				Heaved	Partly heaved	Not heaved
	Unmulched seedling stock					
Austrian pine	2-0	Scalped	Level	16	48	36
Douglas fir	2-0	Furrowed	West	11	17	72
Douglas fir	2-0	Scalped	West	29	42	29
Jack pine	2-0	Scalped	Level	26	15	59
Jack pine	2-0	Furrowed	North	2	6	92
Red pine	2-0	Furrowed	Level	8	19	73
White pine	2-0	Furrowed	East	2	14	84
White spruce	2-0	Furrowed	West	31	34	35
White spruce	2-0	Furrowed	East	14	26	60
Average				15	25	60

Unmulched transplant stock						
Japanese red pine	3-1	Scalped	Level	0	63	37
Pitch pine	3-1	Scalped	Level	2	55	43
European larch	2-1	Furrowed	West	7	35	58
Red spruce	2-1	Furrowed	West	6	40	54
Norway spruce	2-2-1	Scalped	Level	0	21	79
Average				3	43	54
Average of all stock not mulched				11	31	58

Mulched stock						
Austrian pine	2-0	Scalped	Level	4	15	81
Douglas fir	2-0	Furrowed	West	1	19	80
White spruce	2-0	Furrowed	East	6	20	74
Red spruce	2-1	Furrowed	West	2	15	83
Japanese red pine	3-1	Scalped	Level	0	14	86
Average of mulched stock				2	17	81
Average of all stock				8	28	64

out of the ground or had only small portions of the roots still in the soil. Heaved trees were no longer able to remain in a vertical position and probably could not have survived. Trees partly heaved



comprised those raised about one-quarter to one-half inch from the normal planted position. They remained erect and practically all became established. Trees classified as not heaved were in the normal planted position.

The data in Table II are grouped according to (1) unmulched seedling stock, (2) unmulched transplant stock, and (3) mulched stock. Sod from which the soil was shaken was used for mulching. Site preparation and aspect factors are included in the table, but there are insufficient data to bring out clearly their effects.

Although considerable damage occurred during the winter of 1936-37 it was much less than that during 1931-32. This may have been due either to a more favorable winter season in 1936-37 or to the different conditions under which the plantations were established.

Many of the trees completely heaved late in the winter were re-planted during the spring of 1937, and most of them became established successfully. Soil was placed around the trees partly heaved, and little or no mortality resulted among them. It is very important, of course, to replant heaved trees before they have dried seriously.

#### FROST-HEAVING DAMAGE IN 1937-38

Plantings during the fall of 1937 were made on a valley site with slow surface drainage as well as on several well-drained sites. All stock was mulched and planted in furrows. Results are given in Table III.

TABLE III  
FROST HEAVING OF FALL-PLANTED STOCK DURING THE  
WINTER OF 1937-38

Species	Age of stock	Aspect	Heaving percentage		
			Heaved	Partly heaved	Not heaved
White ash	1-0	Level (valley)	33	41	26
Norway spruce	3-0	Level (valley)	46	27	27
Green ash	1-0	West	7	60	33
Norway spruce	2-1	Level	0	14	86
Honey locust	1-0	Level	12	25	63
Average			20	33	47

Most of the trees that heaved during the winter of 1937-38 were replanted in early spring, and many of them became established.

Heaving was particularly severe on the valley site. Despite mulching only 26 per cent of the white ash and only 27 per cent of the Norway spruce escaped damage. A high water table and loam soil probably account for the more severe heaving on the valley site. An added reason may be that green ash and honey locust are taproot species. These appear to be more easily heaved than species with branched-root systems.

#### DISCUSSION

A comparison of damage for the three years shows the highest mortality rate in 1931-32. The rates would have been even higher on the valley site in 1937-38 if no maintenance work had been done. Since, however, the data are not directly comparable it is sufficient to conclude that severe damage was suffered in fall plantings made in each of three years.

Transplant or large stock appears to have a definite advantage over seedling and small stock. Highest losses each year were from heaving of seedling stock. It was especially noted that under field conditions the smaller, weaker trees were the ones most commonly heaved.

Very little heaving occurred after the trees had completed one season's growth. Small 2-0 white spruce, however, heaved over one half as much in the second winter as in the first.

Furrowing gave better protection than did scalping. Table II shows this most clearly. Data in Table I indicate that far greater success was obtained without site preparation, either furrowing or scalping. Though the results may be favorable with respect to frost heaving, lack of site preparation may subject the young trees to an even more serious factor, plant competition.

The value of mulching is well illustrated in the data for all three years, especially those for 1936-37, when only two per cent of all mulched stock was seriously heaved. Of course, mulching required additional time. At the Kellogg tract it increased the cost of planting by 50 per cent.

Maintenance work in replanting heaved trees and tending those partly heaved added an average of 30 per cent to the original planting costs. On the basis of these tests fall planting with mulching and

maintenance the following spring increases planting costs by about 80 per cent

The data are not sufficient to reveal clearly the relations between aspect and amount of frost heaving, but the level valley site showed by far the greatest amount, and the single plot with a north aspect was least affected

#### PLANTING METHOD TO CONTROL HEAVING

In checking frost-heaving damage in the spring of 1937 it was noted that heaved trees were in exposed places or in small depressions where surface water might accumulate. Trees in the best condition were in well-drained, protected situations. For example, heaved trees had been planted on the north side of furrows plowed in an east-west direction. Trees planted on the south side next to the furrow wall were in excellent condition. Furrows were plowed to a depth of five to six inches and were ten inches wide. Those less than four inches deep did not give complete protection.

In the fall of 1937 there were planted in an east-west direction 2-0 seedlings of red pine, Austrian pine, and white pine, and 1-0 seedlings of honey locust. Trees were set by the hole method next to the south wall of the furrow, and a small mound of soil was built up around each tree. A piece of sod from which the soil had been shaken was placed on the north side of the tree in order to protect it from heaving on that side. Care was taken to compact very firmly the soil about the roots of each tree. The site was well drained and level to slightly rolling. The soil was a gravelly sandy loam.

From a sample of one hundred of each of the four species only three white pine and two honey locust trees were affected and they were only partly heaved. None of these were heaved sufficiently to cause measurable injury. It would seem, therefore, that this method of fall planting may prove useful in southern Michigan or other regions where frost heaving is likely to be serious.

#### SUMMARY

Frost-heaving damage to forest planting stock at the Kellogg reforestation tract is reported for the years 1931-32, 1936-37, and 1937-38. Under ordinary planting methods considerable losses occurred each year.

Heaving was more severe on a valley site with loam soil, slow

surface drainage, and high water table than on any other aspect on which tests were made

Seedling or small, weak stock heaved more than transplant or large stock

Mulching with straw or sod was markedly effective in reducing heaving damage

Almost no injury was suffered by the fall plantings of 1937 that were made under the following conditions: (1) furrows plowed in an east-west direction, (2) furrows narrow, five to six inches deep, (3) trees planted close to the south wall of the furrow, (4) soil packed firmly around roots, (5) soil mounded slightly around base of trees, and (6) north side of tree mulched with sod from which soil had been shaken

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# SOME NOTES ON THE PREPARATION OF *CYATHUS STERCOREUS* AS A TEST OR- GANISM FOR THE RAPID DETERMI- NATION OF DECAY RESISTANCE IN TREATED TIMBERS

FREDERICK H VOGEL

SINCE the publication of the works of Robert Hartig in Germany late in the nineteenth century the relationship of fungous hyphae to decaying wood has been recognized, and much study has been devoted to it both in the field and in the laboratory. Before Hartig's discovery of the relationship there had been numerous confusing theories which retarded the advancement of knowledge and control of wood decay.

There are open to the experimenter three general methods of approach by which the comparative preservative value of given chemicals may be determined. These are clearly described by Hunt and Garratt (4), and their applications are discussed at length by Schmitz and others (5-8, 10-11).

Several fungi are accepted by laboratory technicians as good test organisms. The Forest Products Laboratory at Madison, Wisconsin, recommends strongly a strain of test fungus No. 517, an unidentified isolate from a decayed mine timber (6). The Western Pine Association Research Laboratory in Portland, Oregon,<sup>1</sup> has based considerable work on tests with *Lenzites trabea* (Pers.) Fr., an active dry-rot fungus encountered in actual service. In some European laboratories *Merulius lacrymans* (Wulf.) Fr. is preferred because it is a troublesome building rot in Europe, whereas in this country *Poria incrassata* (B. & C.) Burt., *Coniophora cerebella* Pers., and others are selected for a variety of reasons.

All these fungi have their individual merits as test organisms,

<sup>1</sup> The wood decay studies are conducted under the direction of Dr. E. E. Hubert.

some are to be encountered under natural conditions, some show broad adaptability to wood species and environment, others display rapidity of growth or attack, while certain species are easily grown and propagated in pure culture in the laboratory. One group attacks lignin most strongly, whereas others seem to concentrate on cellulose. None meets all needs.

Several investigators prefer Petri dishes for culture chambers; another group, with equally good reason, employs Kollé flasks. Either utensil has peculiar advantages to commend it. Schmitz (8) and others (5, 7) discuss the advantages and the disadvantages at length.

### *Cyathus stercoreus*

The writer brings forward another fungus, not the answer to the call for an all-purpose test organism but an addition to those already in common use. *Cyathus stercoreus* (Schw.) De Toni deserves further investigation as a fast-working laboratory tool. The genus *Cyathus* is not often studied by forest pathologists, and is seldom looked upon as more than a casual secondary organism on wood previously decayed by other fungi, but a species of it was tested in the forest pathology laboratory of Michigan State College and found to show considerable speed in growth and attack on wood and woody fibers.

The genus *Cyathus* belongs to the subclass Gasteromycetaceae or stomach fungi. It is one of the four genera<sup>2</sup> in the family Nidulariaceae, and is the most common bird's-nest fungus found in the Lake States. Engler and Prantl (2) report it native to North America, the West Indies, Australia, and New Zealand.

In outward appearance the mature sporophores resemble tiny bell-shaped birds' nests, being smooth and plain rather than fluted or striate on the inner surfaces of the cups, and densely matted with short grayish brown hairs on the outside. The fruiting bodies, without their epiphragms (caps), measure about 7 to 10 mm. in height and about 3 mm. in diameter. On mature spore fruits six to twenty peridioles are exposed by rupture of the epiphragms. The peridiole is usually attached to the wall of the fruiting structure by a slender strand called a "funiculus."

To date there has been no success in the writer's effort to germi-

<sup>2</sup> Nidulariaceae is variously recognised to contain three or four genera, the genus *Nidula* is not held to be separate by some mycologists.

nate the spores of *Cyathus* in their peridioles. In nature, germination must come about through the decay of the hard peridiole wall or the breaking of it by animals, birds, or insects. Laboratory propagation is best attained by carefully loosening the newly matured peridioles from the spore fruit and dropping them on malt agar after rinsing them in sterile distilled water or dilute alcohol. Mycelial growth takes place rapidly from the broken funiculi. All of twenty peridioles tested grew abundantly in this way, and only two were contaminated by soil organisms (Actinomycetes). It appears that the Actinomycetes which are ordinarily associated with *Cyathus* in nature affect the fungus by causing the mycelium to grow flat along the agar. Very seldom does the fungus overcome the bacteria in vegetative competition.

The close natural association of *Cyathus* with one or many soil bacteria has gained for it a reputation as a slow-acting decay organism. Antibiosis, or the mutual inhibiting effect of fungus and bacteria, results in a retarded attack on wood by *Cyathus*, which is readily demonstrated in the laboratory. Freed of bacteria, *C. stercoreus* grows with rapidity, with luxuriant mycelium. It hardly resembles the slow-growing contaminated culture.

The normally saprophytic fungus is usually found in and on the soil, on manure or decayed organic matter, but Coker and Couch (1) mention a report of its fruiting on live sugar maple (*Acer saccharum* Marsh.), very probably it was growing without contamination, a condition rather rare in nature. Inoculations have been made by the writer on a living tree, but sufficient time has not yet elapsed for convincing results to appear.

In pure agar culture the mycelial mat grows faster at temperatures of 21° to 27° C. than any other wood-rot fungus tested on this medium. Few molds can equal its rate of hyphal extension; the main exceptions are various species of the Mucorales, on malt-agar plates. Malt agar is quickly bleached white by the growth of *Cyathus*, as it is by the Madison No. 517 fungus. Twisted mycelial sheets may form in the agar, and large drops of water usually occur in the mycelium.

The newly grown mycelium, which is fluffy-white, suggests tufts of down, but it assumes a rufous tinge after several days, and thereafter may darken until it becomes brown. Aërial mycelium is profusely septate and is marked by large clamp connections. While



the mat forms, tawny mycelial strands proliferate radially from the inoculum and quickly carry the fungus over the tops of experimental wood blocks unless the surfaces are highly toxic

### *Technique Employed*

Most of the work has been done on malt agar consisting of 10 to 2.5 per cent Trommer's liquid malt,<sup>2</sup> and 10 to 2.5 per cent bacto-agar. Sterilization of the medium results in less breakdown in the higher concentrations of agar. Since *C. stercorius* must be grown in pure culture in order not to suffer loss of its wood-attacking capacity, the necessity for careful sterilization of the medium is seen.

If partial breakdown of agar does occur during sterilization, it will not impair the value of the medium, but either the precipitate should be settled or the clear agar decanted, otherwise the precipitate will interfere with early detection of contaminants. For fastest results in testing it is recommended that the agar plate be inoculated in several places with pure *C. stercorius*, so that a continuous mat may be formed by the rapid coalescence of separate colonies. The agar should be watched carefully for evidence of contamination until it has been completely covered by mycelium (in from three days to a week).

There was little success in "operating" on cultures to remove Actinomycetes, thermophilic bacteria, or molds. Red-hot needles, spatulas, loops, etc. usually spattered spores or living cells, alcohol in any concentration served only as a temporary inhabitant. Some chemicals, such as copper compounds, were successful in killing contaminants, but they rendered sterile the portion of the agar plate which they touched. Hyphal-tip transfer to a new plate proved most satisfactory. As soon as the mycelial mat covered the agar completely, sterilized wood test strips were laid flat upon the fungus and allowed to remain for the duration of the test.

The sterilization technique of Schmitz, von Schrenk, and Kammerer (9, p. 68) has been followed with excellent results. Moisture in the wood, absorbed in boiling, hastened attack (and prevented the early drying out of the cultures). The intermittent dipping should be done carefully in boiling water, so that the moisture content of the test samples may not become unreasonably high.

When oven sterilization of wood was employed, it was found that

<sup>2</sup> Trommer's Diastase Malt. The Trommer Company, Fremont, Ohio.

excessive dryness of the wood retarded the initial attack by fungi, a consideration of no small importance in rapid determination of decay resistance

The speed with which certain fungi begin to attack an array of woods (and, later, the speed with which they spread over them) may be an important datum related to the durability of the woods. By the use of *C. stercoreus* it was found possible in one week's time to arrange a group of twenty-two native American woods in an order that corresponded almost exactly with relative durability ratings published by the Forest Products Laboratory after lengthy research. It is problematical whether or not the work could be duplicated with the woods of all commercial tree species, but it would appear that initial spread of mycelium is worthy of more study.

Several observations follow on this rapid forecast of decay resistance by noting the appearance of aerial mycelium of *Cyathus*. Aerial mycelia spread rapidly over the sapwood of the species tested in a period of two to four days, provided toxic extractives from certain heartwoods were excluded. In one instance the heart-sap boundary in a durable species (*Catalpa speciosa* Warder) was a razor-sharp line, with heavy mycelial mat on the softwood and absolutely bare heartwood, on some other species there was a heavy mycelium on the sapwood and light on the heartwood. It appears fairly certain that the profuseness of aerial mycelium in *Cyathus* is almost directly proportional to the availability of food in the substratum immediately below. So far no quantitative data have been collected to substantiate the apparent fact, but the close correlation between mycelial growth observed in less than a week on given woods and the published durability list of those woods leads to the belief that fast approximations suitable for industry could be made with about as much accuracy as that of meter indicators of lumber moisture content (3). No laboratory decay-resistance tests can give more than approximations of expected service life, regardless of the accuracy of measurement.

It is recommended that two things be done with cultures in either test tubes or Kollé flasks when it is desired to allow fungi to work on wood until they run their courses to an appreciable loss in oven-dry weight: (1) that the mouths of such test tubes and Kollé flasks be stoppered with the standard cotton plugs, with coverings of Parafilm<sup>4</sup> or similar material put over them to retard drying out; and (2) that

<sup>4</sup> Made by Menasha Products Company, Menasha, Wisconsin.

identifying labels be applied to the bottoms of the containers rather than near their mouths, so that there will be no danger of the mycelium's creeping out of the glassware through the cotton stoppers and obliterating the labels under the sealing material. Such loss was experienced with several test fungi

Evidently Parafilm is not gas-tight, for not only do aerobic fungi appear to grow well when sealed with it, but also strong odors such as those of some Actinomycetes may be readily detected through it. Nevertheless, it retards the loss of moisture to the extent that test-tube cultures may be kept in excellent condition for at least a year without noticeable shrinking of the agar. Matched unsealed cultures would long before have shriveled to a stony mass. Of course, a high-humidity chamber would answer the same purpose.

It is recommended that at the end of the test period the test blocks be removed unsterilized from the culture chambers, so that careful inspection may be made of them, unhampered by melted agar or heat-browned hyphae. This recommendation should especially be observed with such fungi as may discolor the wood only slightly under natural action of the fungi. The mass of external hyphae may be carefully scraped off and the condition of the wood surface noted before putting the specimens into the oven to determine their final oven-dry weights.

The determination of timber durability is more than a laboratory matter. The present prosperity and the future existence of our lumber industry depend to no small extent upon a more exact knowledge of wood properties. Durability is a factor of greatest importance in many applications of timber.

MICHIGAN STATE COLLEGE  
EAST LANSING, MICHIGAN

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# **ZOÖLOGY**



## THE THOMISIDAE (CRAB SPIDERS) OF MICHIGAN

ARTHUR M CHICKERING

THE crab spiders acquired their name because, in most species, the body is short, broad, and more or less flattened; the legs usually have a conspicuously crablike position, and locomotion seems to be accomplished as readily sidewise and backward as forward. These spiders spin no definite web for the capture of food but either actively pursue their prey or lie in wait for it protected by their concealing coloration. Most members of the family are drably marked with grays and browns but some are brightly colored to match the flowers within which they lie in ambush. Gabritschevsky (1927) experimentally proved what araneologists have long believed, that such spiders as *Misumena vatia* have the ability to change their colors to correspond rather closely to their background. He showed that immature female spiderlings are incapable of assuming a white or a yellow color when raised on white or yellow paper. On the other hand he found that after the last moult these spiders become very sensitive to reflected light. When adult white females are placed on yellow paper they become yellow in about ten days and change back to white in five or six days when replaced on white paper.

In agreement with my former practice (1939) I have included in this paper only what I consider to be the essential synonymy. In view of the purpose and the probable uses of this series of publications I can see no adequate reason to attempt here a complete summary of the involved synonymy which now exists for many species.

Measurements, color, and other characteristics of the species treated in this paper are defined as stated in my recent article on the Anyphaenidae and Clubionidae of Michigan (1939).

Although changes which may seem somewhat confusing have been recently made in the nomenclature of the Thomisidae only two species treated here have not been reported previously. *Tibellus duttoni* (Hents) and *Xysticus emertoni* Keyserling.



The figures numbered 16, 17, 21-26, 45, 51-54, 62, 63, 65-68, 71, 72, 74, 75, 79, 82, and 83 were made from specimens in the Museum of Comparative Zoölogy at Harvard College. All others are from specimens in the author's private collection.

It is again a pleasure to express my gratitude for the help of zoölogists and friends. Several years ago in connection with an extensive study of the Thomisidae of the United States Dr. Willis J. Gertsch of the American Museum of Natural History examined and identified the entire accumulation of this family which I then owned. Considerable material has since been added to my collection and changes have been made in the determinations, but I am greatly indebted to Dr. Gertsch for his aid at a time when it was very much needed. On two separate occasions during the past year Mr. Nathan Banks gave me the privilege of working in his laboratory and of studying the extensive collections of Thomisidae in the Museum of Comparative Zoölogy. Miss Elizabeth B. Bryant, of the same museum, helped me repeatedly with numerous valuable suggestions regarding identification and synonymy, together with the loan of many books and reprints absolutely indispensable for the successful pursuit of my studies.

The thirty-one species of Thomisidae now known to occur in Michigan are grouped in two subfamilies as follows:

#### MISUMENINAE

<i>Coriarachne versicolor</i> Keyserling	<i>X elegans</i> Keyserling
<i>Misumena vatia</i> (Clerck)	<i>X emertoni</i> Keyserling
<i>Misumenoides alectorum</i> (Hentz)	<i>X ferox</i> (Hentz)
<i>Misumenops asperatus</i> (Hentz)	<i>X fraternus</i> Banks
<i>M. oblongus</i> (Keyserling)	<i>X funestus</i> Keyserling
<i>Oxyptila americana</i> Banks	<i>X graminis</i> Emerton
<i>O. conspurcata</i> Thorell	<i>X gulosus</i> Keyserling
<i>Tmarus angulatus</i> (Walckenaer)	<i>X triguttatus</i> Keyserling
<i>Xysticus discursans</i> Keyserling	

#### PHILODROMINAE

<i>Ebo latithorax</i> Keyserling	<i>P. permix</i> Blackwall
<i>Philodromus aureolus</i> (Clerck)	<i>P. rufus</i> Walckenaer
<i>P. exilis</i> Banks	<i>P. satullus</i> Keyserling
<i>P. imbecillus</i> Keyserling	<i>Thanatus formicinus</i> (Clerck)
<i>P. infuscatus</i> Keyserling	<i>Tibellus duttoni</i> (Hentz)
<i>P. marxi</i> Keyserling	<i>T. maritimus</i> (Menge)
<i>P. mineri</i> Gertsch	<i>T. oblongus</i> (Walckenaer)

These two subfamilies may be separated by the following key.

1. First and second tarsi not scopulate beneath, third and fourth pairs of legs usually much shorter than first and second pairs, promargin of fang groove without teeth Misumeninae, p 191
- 1 First and second tarsi usually scopulate beneath; third and fourth pairs of legs not much shorter than first and second pairs, promargin of fang groove with one or two teeth Philodrominae, p 217

## MISUMENINAE

### KEY TO GENERA OF MISUMENINAE

1. Spines rare or lacking except beneath tibiae and metatarsi, body and legs white or yellow, often with crimson or dark stripes or spots (males small and much more highly colored) 2
- 1 Spines common on body and legs, body and legs usually deeply colored with reddish browns and grays 3
- 2 A prominent white band connecting the two groups of lateral eyes between the two rows; also a white band and ridge between anterior eyes and ventral margin of clypeus and extending laterally behind eye region Misumenoides, p 194
- 2 No prominent white band connecting the two groups of lateral eyes, no white band and ridge between anterior eyes and ventral margin of clypeus Misumena, p 192
- 3 Only two pairs of ventral tibial spines on first two pairs of legs, ocular quadrangle slightly longer than wide behind; clavate bristles numerous Oxyptila, p 198
- 3 More than two pairs of ventral tibial spines on first two pairs of legs, ocular quadrangle always wider behind than long, clavate bristles lacking or rare 4
- 4 Abdomen high and pointed behind, chelicerae porrect, clypeus slanting forward Tmarus, p 201
- 4 Abdomen either flat or of moderate height and never pointed behind, chelicerae and clypeus vertical 5
- 5 Posterior median eyes as large as posterior laterals, color usually pale yellow with dull red markings, somewhat hairy in general appearance Misumenops, p 195
- 5 Posterior median eyes always smaller than posterior laterals; color of background always yellowish, with deep reddish brown markings which may become almost black; not so hairy in general appearance 6
- 6 Cephalothorax strongly depressed and flat; males without definite palpal tarsal tutacula and apophyses Coriarachne, p 192
- 6 Cephalothorax not strongly depressed, usually quite convex, males with definite palpal tarsal tutacula and apophyses Xysticus, p 202

## GENUS CORIARACHNE THORELL, 1870

*Coriarachne versicolor* Keyserling*Xysticus versicolor* Simon, 1895*X. versicolor* Petrunkevitch, 1911*C. versicolor* Comstock, 1913*Platyzysticus versicolor* Gertsch, 1932.

(Figures 1-3)

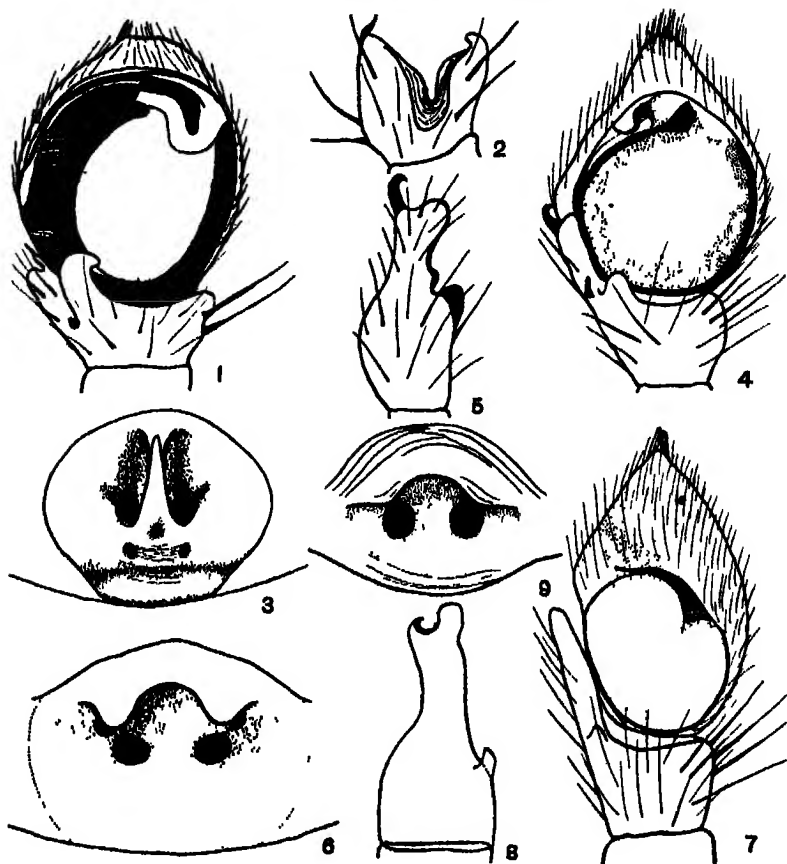
This species closely resembles a *Xysticus* and has frequently been considered a member of that genus, but its features probably distinguish it as a *Coriarachne*. The cephalothorax is strongly depressed, rounded, and very flat, the abdomen, also, is much flattened. In its form the species seems to be well adapted to a life beneath bark, stones, and the like. The color is a highly variable mixture of grays and browns on a yellowish background. Some individuals are so dark as to appear almost black, others are much lighter. Good descriptions of the color have been published by Emerton (1902) and Comstock (1913). The male palp bears two stout tibial apophyses which are nearly equal in size, the dorsal one terminating in a short somewhat bent style (Figs 1-2). The epigynum (Fig 3) is a raised area with a convex septum, on each side of which is a shallow cavity. I have both sexes in my collection, and specimens from several localities in the Southern Peninsula and from Marquette in the Northern Peninsula.

## GENUS MISUMENA LATREILLE, 1804

*Misumena vatia* (Clerck)*Araneus vatius* Clerck, 1757*Thomisus dauci* Hahn, 1831.*T. citreus* Walckenaer, 1837*T. fartus* Hentz, 1847.*Misumena vatia* Simon, 1875

(Figures 4-6)

The frequent occurrence of this species on flowers and its bright coloration have helped to make it one of our best-known thomisid spiders. Females are milk-white or bright yellow, usually with a light red, dorsolateral abdominal stripe on each side and a patch of the same color in the region of the central eyes. The red color may



# EXTERNAL ANATOMY OF SPIDERS

(Figures 1-9)

- 1 *Coriarachne varicolor*, male palpus, ventral view
- 2 *C. varicolor*, tibia, retrolateral view
- 3 *C. varicolor*, epigynum
- 4 *Misumena vatia*, male palpus, ventral view
- 5 *M. vatia*, tibia, retrolateral view
- 6 *M. vatia*, epigynum
- 7 *Misumenoides aleatorius*, male palpus, ventral view
- 8 *M. aleatorius*, tibia, retrolateral view
- 9 *M. aleatorius*, epigynum

be nearly, or even entirely, lacking. Emerton (1902) and Comstock (1913) have furnished good figures of the color and form of the female of this species. Males usually have the first two pairs of legs all red except the tarsi, which are partly yellowish. The last two pairs of legs are yellowish or white. The cephalothorax is reddish and ordinarily has a central light stripe about as wide as the distance between the anterior lateral eyes. There are two lateral and two dorsal abdominal reddish stripes, the latter more or less broken into spots. Spines are rare except beneath the tibiae and the metatarsi of the first two pairs of legs. Females sometimes reach a length of 12 mm or even more, but those in my collection average about 8 mm when mature. Males, however, are only about 3 mm long and are much slenderer with proportionately longer legs. The male palp (Figs 4-5) has two lateral tibial apophyses, the ventral one being short and blunt whereas the dorsal one is long and stout and terminates in a prominent hook. The epigynum (Fig. 6) is a raised, somewhat dome-shaped structure. There is a transverse shelf with two lobes pointing backward, and posterior to each of these lies an aperture, partly beneath an obscure fold. This species is widely distributed over North America and Europe, and I have collected it from many localities in both peninsulas of Michigan.

#### GENUS MISUMENOIDES F. CAMBRIDGE, 1900

##### *Misumenoides aleatorius* (Hentz)

*Thomisus aleatorius* Hentz, 1847

*Runcinia brendeli* Keyserling, 1880

*R. aleatoria* Banks, 1892

*Misumena aleatoria* Emerton, 1892

(Figures 7-9)

This species resembles *Misumena vatia* to some extent and may at times be mistaken for it. Most commonly the females are white or yellow without markings, but sometimes they have dark spots or stripes where the crimson stripes occur in *M. vatia*. They may also have dark spots elsewhere on the abdomen and legs. In life the males have a bright green cephalothorax, often with brown along the sides; the abdomen is bright yellow. The first two pairs of legs are dark brown and the others are light-colored. The females in my

collection average only about 5.5 mm long, but individuals often reach a length of 8 or 9 mm. The males are about 3 mm long and proportionately longer-legged. This is another species which frequents flowers. It is widely distributed over the whole of the United States and most of Canada, but it does not seem to be a common species in Michigan. I have both sexes in my collection, however, taken from a few localities in the southern part of the state. Other than the features of the external genitalia the most distinguishing characteristic is the presence of a white line connecting the lateral eyes of each side and extending between the two rows of eyes. There is also a white line on a low ridge extending along the ventral margin of the clypeus and laterally on both sides considerably posterior to the eye region. The epigynum (Fig. 9) is somewhat like that of *M. vaha* but is less complicated. The male palp (Figs 7-8) is provided with two lateral tibial apophyses, the ventral one being reduced to a small spur, the dorsal one is long, stout, and provided distally with a blunt process and a sharp hook.

#### GENUS MISUMENOPS F. CAMBRIDGE, 1900

There is some doubt regarding the validity of this genus, and Cambridge admitted when he established it that it was a "genus of convenience." It is closely related to *Misumena* but can be distinguished from it by the following features. The spines on the legs and body are more numerous, the lateral eyes are more closely connected by a rounded ridge, the anterior row of eyes is less strongly recurved, and the posterior row more strongly recurved. Two species appear in my collection, they may be separated by the following key.

#### KEY TO THE SPECIES OF *MISUMENOPS*

##### MALES

- 1 Palpal tarsal embolus extended retrolaterally, where it describes almost a complete circle; dorsal lateral tibial apophysis elongated and extended parallel to tarsus for about one fourth the length of the latter; cephalothorax usually with two dorsolateral reddish stripes  
*M. asperatus*, p. 196
- 1 Palpal tarsal embolus not extended retrolaterally, dorsal lateral palpal tibial apophysis not elongated and extended parallel to tarsus, cephalothorax usually without conspicuous reddish markings  
*M. oblongus*, p. 197

## FEMALES

- 1 Numerous spines and bristles on body and legs, typically pale yellow with dull red markings, epigynum with a prominent cavity separated within into two smaller cavities by a central septum *M asperatus*, p 196
- 1 Fewer spines and bristles on body and legs, typically pale yellow or white with few or no red markings, epigynum with an obscure central lobe, on each side of which is a curved tube and behind which are two shallow cavities *M oblongus*, p 197

*Misumenops asperatus* (Hentz)*Thomisus asperatus* Hentz, 1847*Misumena rosea* Keyserling, 1880*M foliata* Banks, 1892*M placida* Banks, 1892*M asperata* Emerton, 1892*Misumessus asperatus* Banks, 1907*M asperatus* Comstock, 1913

(Figures 10-12)

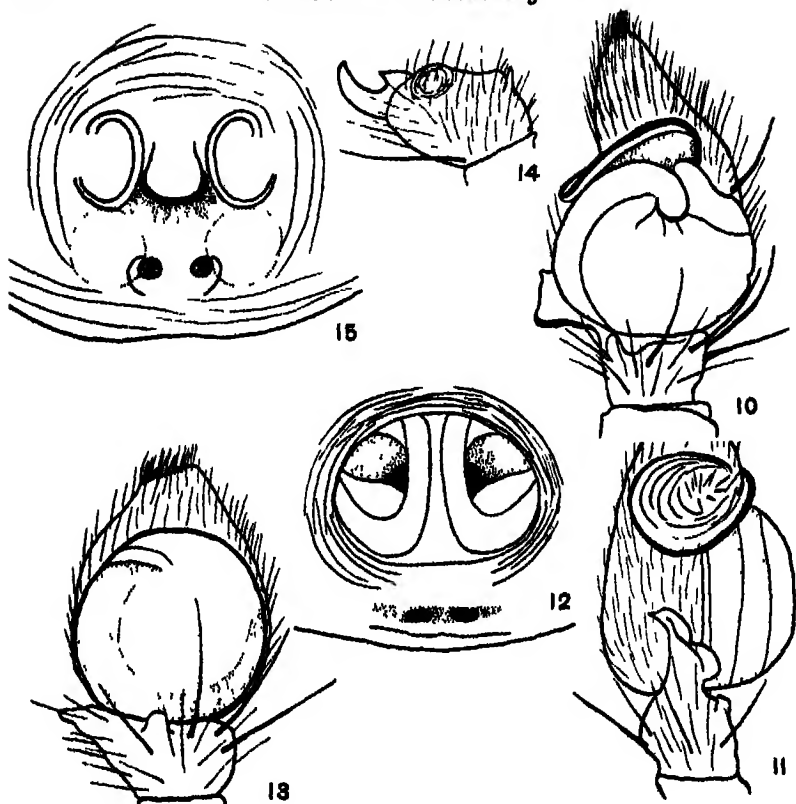
This is a species with a wide distribution through the United States east of the Rocky Mountains, through Canada, Mexico, much of Central America, and the West Indies. It is a very common species in Michigan and often is abundant in open fields. I have numerous specimens of both sexes from many localities in the Southern Peninsula but no specimens from the Northern Peninsula. Females are about 6 or 7 mm long and are usually pale yellow, with dull reddish markings which are frequently lost in alcoholic preservation. Two dorsolateral cephalothoracic reddish brown stripes generally occur. There is a central basal abdominal stripe and two lateral stripes. Behind the central stripe is a double series of spots on the posterior half of the abdomen. The underparts are yellowish. Frequently the legs are spotted with reddish brown. Males are about 3.5 to 4 mm long. They have the same color markings as females but the colors are brighter and cover more area. The male palp is very distinctive in having a much-twisted embolus which extends retrolaterally and there makes almost a complete circle within a depression in the cymbium (Figs 10-11). Of the two lateral palpal tibial apophyses the ventral one is reduced to a short blunt process, whereas the dorsal one is long, stout, and irregular distally. The epigynum (Fig 12) consists of a rather conspicuous cavity within which are two smaller cavities separated by a central septum.

*Misumenops oblongus* (Keyserling)*Misumena oblonga* Keyserling, 1880*Misumessus oblongus* Banks, 1904

(Figures 13-15)

*Misumenops oblongus* is known from a large part of the United States east of the Rocky Mountains and from the Southwest, but it seems to occur in Michigan much less frequently than does *M. asperatus*. I have several mature males from different localities in the Southern Peninsula but only one mature female. So far as I know the species has not been collected in the Northern Peninsula. The females from the Southern Peninsula are less spiny and have fewer bristles than has *M. asperatus*. They are usually without distinct color markings. The abdomen is a glistening white, the other parts yellowish. All my specimens were taken from weeds and flowers, where they may be confused with *M. vatia*. They are about 5 mm long. Males are well supplied with erect spines, which tend to be arranged in rather definite rows. The yellowish cephalothorax has a narrow red margin. Numerous glistening white patches and a central double row of reddish spots appear on the yellowish abdomen. Red spots may also occur in other parts of the body, and the anterior spinnerets and the postabdomen are ordinarily red. There is likewise a good deal of red on the legs, which is usually distributed as follows. The first two pairs of femora are red distally and each has a row of prolateral red spots, the patellae are red distally, the tibiae are red both distally and proximally, the metatarsi and tarsi are red for the distal half or two thirds. The other two pairs of legs are yellowish except for a few isolated spots. The males are about 2.5 mm long. The most distinctive feature of the male palp is the very wide tibia. There are two tibial apophyses, the ventral one reduced to a short blunt process, the dorsal one extending laterally and terminating in a characteristic hook (Figs 13-14). The epigynum (Fig 15) is distinctive because it has a central lobe with an obscure curved tube on either side of it. The two dotted areas behind the lobe may be shallow depressions. They show as such on some of the specimens in the Museum of Comparative Zoology. Still further posteriorly there are two small apertures about 1.5 diameters apart.





## EXTERNAL ANATOMY OF SPIDERS

(Figures 10-15)

- 10 *Misumenops asperatus*, male palpus, ventral view
- 11 *M. asperatus*, tibia and base of tarsus, retrolateral view
- 12 *M. asperatus*, epigynum
- 13 *Misumenops oblongus*, male palpus, ventral view
- 14 *M. oblongus*, tibia, retrolateral view
- 15 *M. oblongus*, epigynum

## GENUS OXYPTILA SIMON, 1864

A good revision of this genus based upon the material in the Museum of Comparative Zoölogy was published in 1930 by Miss Elisabeth Bryant. Nine species were recognized at that time and

more have been described since. Only two of these are known to me from Michigan. They are small, inconspicuously marked, and apparently live on the ground among dead leaves and other debris from which they may be sifted. Such facts may account for their uncommon occurrence in museum collections. The median ocular quadrangle is slightly longer than wide behind and usually has parallel sides. Both rows of eyes are recurved, the posterior medians being much smaller than the posterior laterals and farther from them than from one another. The tibiae of the first two pairs of legs each bear two pairs of ventral spines and the corresponding metatarsi each bear three pairs. The presence of numerous clavate bristles is also a good generic character and their distribution may have specific value. The dark reddish brown color patterns are so variable that they are unreliable for purposes of identification. The characters of the male palp make it easy to place the males of our species, but the epigyna seem to be so variable that they are less trustworthy than usual. The prominent anterior lobe or "peg" appears to be a good generic feature in all females.

KEY TO THE SPECIES OF *OXYPTILA*

## MALES

- 1 Dorsal palpal tibial apophysis reaches to about middle of tarsus, ventral palpal tibial apophysis expanded distally, tip of embolus somewhat flattened *O americana*, p 199
- 1 Dorsal palpal tibial apophysis reaches well beyond middle of tarsus, ventral palpal tibial apophysis blunt but not expanded distally, tip of embolus not flattened *O conspurcata*, p 201

## FEMALES

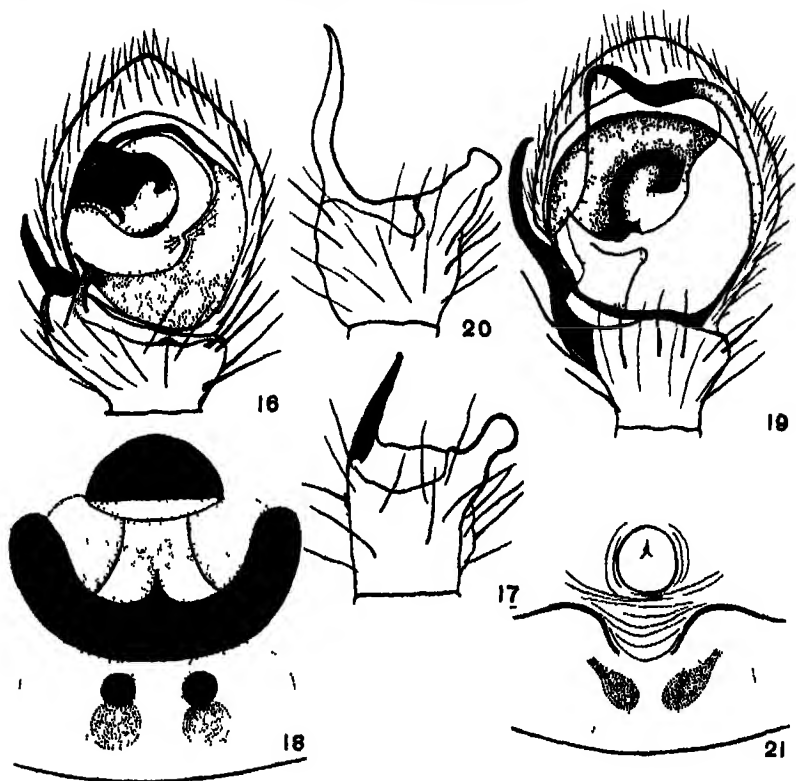
1. Epigynum with a broad U-shaped procurved ridge; tip of median epigynal "peg" hemispherical as seen from below *O americana*, p 199
- 1 Epigynum with a pair of mildly developed ridges not united medially, tip of median epigynal "peg" not hemispherical as seen from below *O conspurcata*, p 201

*Oxyptila americana* Banks

*O conspurcata* Emerton, 1894 (in part).

(Figures 16-18)

Only females of the species have been taken by me in Michigan but I have this sex from both peninsulas. The species is probably a typical northern one. Females have a median light-colored cephalo-



## EXTERNAL ANATOMY OF SPIDERS

(Figures 16-21)

- 16 *Oxyptila americana*, male palpus, ventral view
- 17 *O. americana*, tibia, retrolateral view
- 18 *O. americana*, epigynum
- 19. *Oxyptila conspurcata*, male palpus, ventral view
- 20 *O. conspurcata*, tibia, retrolateral view
- 21 *O. conspurcata*, epigynum

thoracic stripe with a brown stripe on each side of it and a dark irregular margin. There is a little cream color between the rows of eyes. The abdomen is covered with brown spots and cream-colored stripes. The sternum and coxae are light brown, with the venter mottled with brown. The legs are generally brown. Females are about 4 mm long and males about 3 mm. When it is typically

developed the epigynum (Fig 18) is a broad U-shaped transverse fold partly enclosing a prominent cavity. Anterior to the fold is the conspicuous median "peg," the tip of which is hemispherical when viewed from below. Posterior to the fold are two small circular spots about 1.5 diameters apart. Males are colored much like the females. Of the two lateral tibial palpal apophyses (Figs 16-17) the dorsal one is slender, pointed, and reaches to about the middle of the tarsus, the ventral one is shorter and expanded distally. The tip of the embolus is somewhat flattened.

*Oxyptila conspurcata* Thorell

*O. georgiana* Keyserling, 1880

*O. conspurcata* Emerton, 1894 (in part)

(Figures 19-21)

This species is represented in my collection by a single male about 3 mm long. Females in the Museum of Comparative Zoology are about 4 mm long. The cephalothorax of my male specimen is brown, with a median light stripe and an irregular dark spot on each side of it. The abdomen is generally cream-colored above and has two pairs of elongated dark spots near the center. The sternum and coxae are light and the venter is light with dark spots. The male palp has two lateral tibial apophyses (Figs 19-20), the dorsal one being long, slender, and extended well beyond the middle of the tarsus, whereas the ventral one is shorter and blunt at its distal end. The epigynum (Fig 21) shows a pair of mildly developed folds not meeting ventrally. Anterior to these folds is the usual "peg," which is not hemispherical when viewed from below, and posterior to them are two elongated spots less than a diameter apart.

GENUS TMARUS SIMON, 1875

*Tmarus angulatus* (Walckenaer)

*Thomisus angulatus* Walckenaer, 1837

*T. caudatus* Hentz, 1847

*Tmarus rubromaculatus* Keyserling, 1880

*T. caudatus* Emerton, 1892

*T. angulatus* Comstock, 1913

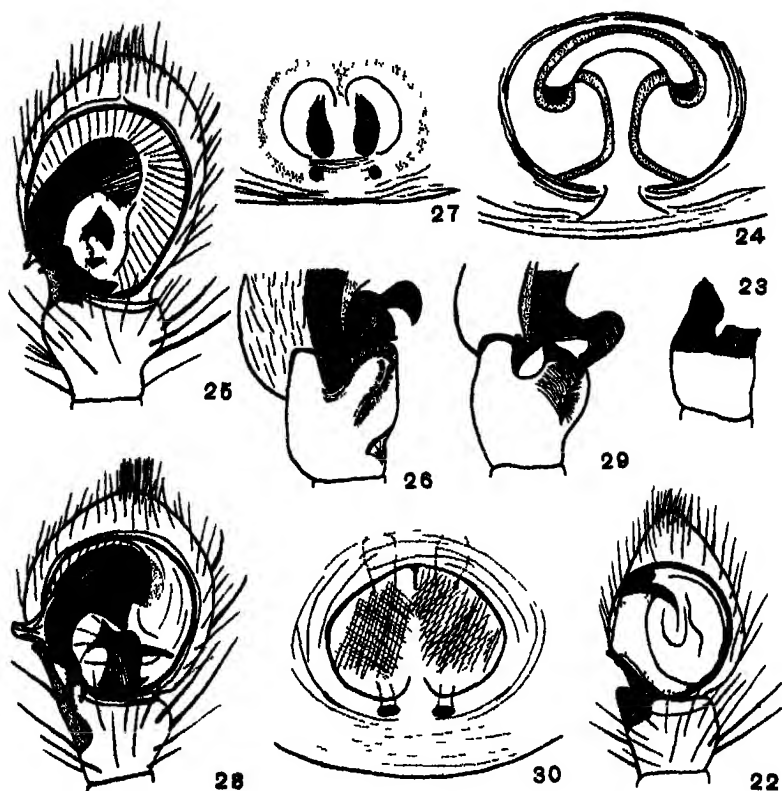
(Figures 22-24)

*Tmarus angulatus* is our only northern member of a genus which has many species in tropical regions. Several are known from the

southern states and Gertsch (1936) has recently described a new one from Texas. *T. angulatus* is easily identified because its abdomen is high and pointed behind, although this characteristic is less pronounced in the males. Emerton's (1902) and Comstock's (1913) figures are useful to show the form and the distinctive features. It will be noted that the body in *Tmarus* is more elongated than in any other of our Michigan Misumeninae. When at rest upon plants, where they most commonly occur, these spiders "hunch" themselves into a compact form, which, together with their protective coloration, gives them a certain measure of security. The clypeus slants forward instead of being vertical as in most of our Thomisidae. The chelicerae are quite porrect. Males are about 5 mm long, females are somewhat larger and may reach a length of 8 mm. The cephalothorax and abdomen show a mixture of dull grays, browns, and reds. An irregular light central patch occurs on the cephalothorax just behind the middle, and from this light patch three white lines usually radiate to the eye region and others extend laterally and posteriorly. The legs are much spotted with dark brown. The underparts are all light-colored but they are sometimes spotted a little with dark colors. The epigynum (Fig 24) has a shallow crescentic recurved groove surrounded by a series of tubes showing through from within, the whole making a rather complicated design. The most characteristic feature of the male palpus (Figs 22-23) is the presence of two lateral apophyses, the ventral one being short, and angular at its distal end, and the dorsal one being more than twice as long and pointed distally.

#### GENUS XYSTICUS C KOCH, 1835

More than half of all our Michigan Misumeninae belong to this interesting genus, which includes more species than any other genus in the Thomisidae. Thirty-two species were listed from France by Berland and Fage (Simon, 1932), and Comstock (1913) stated that about forty species were known from the United States alone. Petrunkevitch (1911) listed about fifty from the whole Western Hemisphere. Many new species have been described during the past ten or fifteen years by Bryant (1930, 1933), Chamberlin (1925, 1929), and Gertsch (1933, 1934). In recent years much synonymizing and revision have been carried out. Gertsch (1934 and in unpublished



## EXTERNAL ANATOMY OF SPIDERS

(Figures 22-30)

- 22 *Tmarus angulatus*, male palpus, ventral view
- 23 *T. angulatus*, tibia, retrolateral view
- 24 *T. angulatus*, epigynum
- 25 *Xysticus discureans*, male palpus, ventral view
- 26 *X. discureans*, tibia and base of tarsus, retrolateral view
- 27. *X. discureans*, epigynum
- 28 *Xysticus elegans*, male palpus, ventral view
- 29 *X. elegans*, tibia and base of tarsus, retrolateral view
- 30 *X. elegans*, epigynum

material) has made a very careful study of this genus in his extensive treatment of the Thomisidae. I am depending largely upon his decisions for the synonyms recognized in this paper, although I have

personally checked each species and made careful examinations of many individuals in the collections of the Museum of Comparative Zoology. It is probably safe to state that there are now more than fifty known species in the United States. *Xysticus* is a typical temperate-zone genus, only a few species being known from tropical and subtropical regions. In her recent extensive study of Cuban spiders Miss Elizabeth Bryant found only one *Xysticus*, and this is soon to be described as a new species. The colors in the genus are usually various shades of grays and browns arranged in spots, bands, and streaks, all more or less mixed with yellowish spots and streaks. These spiders live on herbs, low bushes, fences, the bark of trees, and the like. Frequently they can be found beneath stones, boards, dead bark, and brush. The median ocular quadrangle is almost as wide in front as behind, and a little wider than long. The anterior median eyes are much smaller than the anterior laterals and farther from one another than from the anterior laterals. The posterior median eyes are also smaller than the posterior laterals but closer to one another than to the posterior laterals. The anterior row of eyes is gently recurved, the posterior row strongly recurved. The tibiae and the metatarsi of the first two pairs of legs usually have more than three pairs of ventral spines apiece, and the tarsal claws each have five or six teeth. The body and legs are well supplied with spines and simple bristles but never have clavate bristles. The palpus of the male always bears a tutaculum on the retrolateral side of the cymbium for the reception of the tip of the embolus. Two more or less well developed tarsal apophyses always occur and are of great importance in determining species.

## KEY TO THE SPECIES OF *XYSTICUS*

### MALES

- Palpal bulb with a long flat plate extending across its face (Fig. 37), the two palpal tibial apophyses nearly equal in size and similar in form, anterior tarsal apophysis obscure, posterior apophysis a long slender rod extending obliquely across bulb *X. fraternus*, p. 211
- 1 Features of palpal bulb and tibial apophyses not as above 2
  - 2 Palpal tarsal apophyses enlarged and elongated transversely across bulb, length of posterior apophysis nearly equal to width of bulb (Fig. 31), two tibial apophyses very unequal in length, dorsal one half the length of tarsus *X. emertoni*, p. 208
  - 2 Features of tarsal and tibial apophyses not as above 3

- 3 Palpal tarsal apophyses generally reduced in size, anterior one beaklike (Figs 25-26) and turned toward the tibia, posterior one small, directed medially, dorsal lateral tibial apophysis simple and blunt distally, ventral apophysis deeply excavated *X discursans*, p 206
- 3 Features of palpal tarsal and tibial apophyses not as above 4
- 4 Palpal tarsal apophyses (Figs 28-29) originate close together, massive posterior one expanded distally and turned toward tibia, slender anterior one turned medially, dorsal lateral palpal tibial apophysis a simple obtuse process, ventral apophysis folded and intricately excavated distally *X elegans*, p 207
- 4 Features of palpal tarsal and tibial apophyses not as above 5
- 5 Palpal tarsal apophyses (Fig 40) slender and more or less twisted about one another, dorsal lateral tibial apophysis a simple blade-like process, ventral apophysis extended distally into an oblique beaklike extension *X funestus*, p 212
- 5 Features of palpal tarsal and tibial apophyses not as above 6
- 6 Anterior palpal tarsal apophysis attached near its middle and obliquely elongated (Figs 34, 43) 7
- 6 Anterior palpal tarsal apophysis not attached near its middle and obliquely elongated 8
- 7 Anterior palpal tarsal apophysis about one third as long as tarsus and meets the posterior apophysis, which is slender, free, and elongated (Figs 43-44), ventral lateral tibial apophysis simple, distal end turned medially *X gramineus*, p 213
- 7 Anterior palpal tarsal apophysis (Figs 34-35) much less than one third as long as tarsus and does not meet posterior apophysis, which is not slender, free, and elongated *X ferox*, p 210
- 8 Palpal tarsal apophyses larger, turned medially toward each other (Figs 49-50), dorsal lateral tibial apophysis narrowed to a point distally, ventral apophysis extended into an oblique beaklike organ distally *X triguttatus*, p 216
- 8 Palpal tarsal apophyses smaller, turned toward tibia and, less distinctly, toward each other (Figs 46-47), dorsal lateral tibial apophysis not pointed distally and ventral apophysis not extended into an oblique beaklike organ *X gulosus*, p 214

## FEMALES

- 1 Epigynum with a pair of more or less prominent central longitudinal folds (ridges) 2
- 1 Epigynum without central longitudinal folds 6
- 2 Main part of epigynum nearly as long as broad, enclosing two prominent longitudinal ovoid bodies (folds) situated close together (Fig 48) *X gulosus*, p 214
- 2 Main part of epigynum much broader than long and without such ovoid bodies as above 3
- 3 Main part of epigynum about twice as broad as long, with longitudinal folds farther apart and essentially parallel or slightly diverging posteriorly (Fig 45) *X gramineus*, p 213
- 3 Main portion of epigynum much less than twice as broad as long, with longitudinal folds closer together and converging posteriorly to some extent 4



- 4 A larger species, longitudinal epigynal folds attached closer to anterior rim and less elevated (Fig 42) *X funestus*, p 212
- 4 Smaller species, longitudinal epigynal folds not attached so closely to anterior rim and much more elevated 5
- 5 Longitudinal epigynal folds more massive, less of a channel between them, somewhat farther apart (Fig 27); a somewhat larger species not notably whitish dorsally on abdomen, spermathecae more than three diameters apart *X discursans*, p. 208
- 5 Longitudinal epigynal folds less massive (thin plates), more of an enclosed channel between them, somewhat closer together (Fig 51), a smaller species with a whitish abdomen dorsally, spermathecae only about a diameter of one of them apart *X trigitatus*, p 216
- 6 Depressed region of the epigynum distinctly divided into a deeper anterior part and a shallower posterior part (Fig 33); spermathecae included within the main area and less than one diameter apart *X emertoni*, p 208
- 6 Main part of the epigynum not distinctly divided into a deeper anterior part and a shallower posterior part, spermathecae not included in the main area 7
- 7 Excavated portion of the epigynum distinctly subdivided into two smaller lateral depressions separated by a broad low septum (Fig 39) *X fraternus*, p 211
- 7 Excavated portion of the epigynum not subdivided into two smaller lateral depressions by a broad low septum 8
- 8 Excavated part of the epigynum indistinctly separated into two parts by a low narrow central septum, no tubes visible from within (Fig 30) *X elegans*, p 207
- 8 Excavated part of the epigynum not divided into separate divisions by a central septum, several tubes showing from within (Fig 36) *X ferox*, p 210

### *Xysticus discursans* Keyserling

*Oxyptila cinerea* Emerton, 1892

*X vernalis* Bryant, 1930

*X canadensis* Gertsch, 1934 (new name)

(Figures 25-27)

*Xysticus discursans* is now known from many localities from Nova Scotia across the continent to California and Alaska and, in the east, as far south as Alabama. I have only two mature females to represent the species from Michigan, both collected in the vicinity of Albion. Females are 5.5 mm long and males about 3.5 mm. In females the cephalothorax and the legs are light brown, much spotted and striped with dark brown or black. There is a light central cephalothoracic stripe about as wide as the eye group and a black spot just where the posterior declivity begins. The abdomen is light

gray dorsally with black bars across the posterior end. The epigynum (Fig. 27) is mildly excavated, considerably wider than long, and has a pair of prominent folds which are distinctly swollen posteriorly and about as far apart as the greatest diameter of one of them. The spermathecae are small and separated from one another by about three times the diameter of one of them. In this species the tibiae of the first two pairs of legs are said to bear four pairs of ventral spines, and the corresponding metatarsi three pairs, but, since I have noticed several discrepancies, I think there must be considerable variation in this character. Miss Bryant (1930) has published a good description of the male. Its markings are more vivid than those of the female but otherwise the coloration is very similar. The male palpus (Figs. 25-26) has two tarsal apophyses, the anterior one being a stout beaklike structure and the posterior one a shorter, slenderer tooth. The more dorsal of the two tibial apophyses ends in an obtuse recurved edge, the ventral apophysis is more massive and is quite deeply excavated retrolaterally. Miss Bryant kindly called my attention to the fact that *Oxyptila cinerea* Emerton is a synonym for *X. discursans* Keyserling, I have confirmed this by examination of Emerton's type.

*Xysticus elegans* Keyserling

*X. limbatus* Keyserling, 1880 (female)

*X. limbatus* Emerton, 1892

*X. elegans* Comstock, 1913 (male)

*X. elegans* Gertsch, 1934

(Figures 28-30)

This is one of our largest *Xysticus* and the most common in Michigan. Males are about 5.5 mm long, females 7.5 to 8 mm. Males are quite striking because of their strongly contrasting colors. A broad light stripe bordered on each side with a yellow line runs through the center of the cephalothorax, and a yellow-transverse line also occurs between the two rows of eyes. Dorsally the abdomen is divided into four pairs of large brown patches separated by cream-colored stripes and crossbands. The cephalothoracic colors of the female are like those of the male, but the abdomen lacks the distinct brown patches. Instead it has indefinite dark areas outlined faintly and brokenly with cream-colored lines. The underparts are much lighter and are closely spotted with small brown dots. The species is known

from several localities in eastern Canada, in New England, southward to Alabama, and westward as far as Colorado. My collection contains numerous examples of the two sexes from both Michigan peninsulas. The epigynum (Fig. 30) contains a prominent cavity indistinctly separated into lateral halves by a low central septum. The spermathecae are oval and separated from one another by a little less than the length of one of them. The male palpus (Figs. 28-29) possesses a pair of tarsal apophyses very unequal in size and dissimilar in shape. They arise close together but quickly diverge. The larger apophysis is stout, expanded distally, and turned at a right angle toward the tibia. The smaller apophysis is a slender spike which projects toward the prolateral side of the tarsus. The dorsal lateral tibial apophysis is a simple, obtuse, and somewhat recurved process, the ventral apophysis is more or less intricately excavated distally.

*Xysticus emertoni* Keyserling

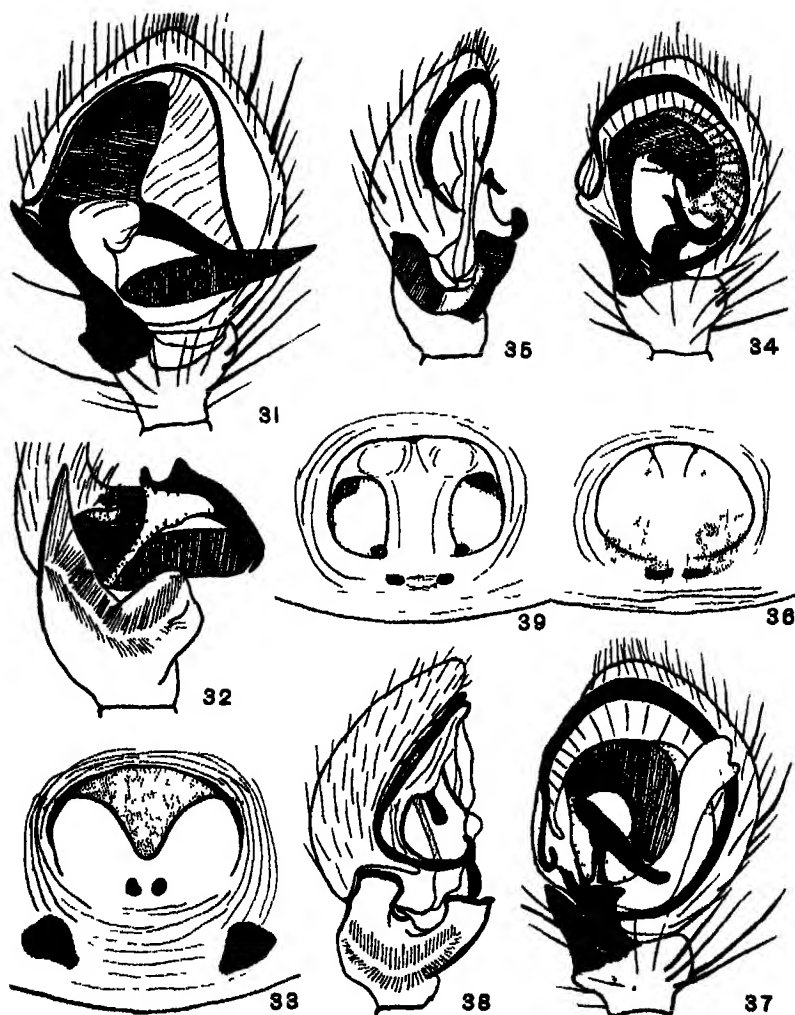
*X. limbatus* Keyserling, 1880 (male)

*X. elegans* Comstock, 1913 (female)

*X. emertoni* Gertsch, 1934

(Figures 31-33)

This is a very widely distributed species, but it is generally regarded as a northern form. In the collection of the Museum of Comparative Zoology there are specimens from several localities in Canada, where it is often abundant, and from New England. There is one female from the mountains of New Mexico. I have both sexes in my Michigan collection from several localities in the vicinity of the University of Michigan Biological Station, Cheboygan County, where I have found the females abundant in July. Females are about 8 mm long, and males about 6 mm. In females the ground color of the cephalothorax is brownish yellow. Along the lateral margin there is usually a narrow white line and just above it a narrow dark line. A broad light central stripe more or less streaked with brown extends as far back as the beginning of the posterior declivity, but beyond this point it continues a clear yellow without markings. The lateral sides are streaked and mottled with brown. The abdomen has an indistinct central lighter area widening posteriorly with a darker stripe on either side of it, across the posterior half are several lighter recurved bars. The dorsolateral sides are considerably lighter. The venter is yellowish and covered with small



EXTERNAL ANATOMY OF SPIDERS

(Figures 31-39)

- |     |  |                                |
|-----|--|--------------------------------|
| 31  | <i>Xysticus emertoni</i> , male palpus, ventral view             |                                |
| 32. | <i>X. emertoni</i> , tibia and base of tarsus, retrolateral view |                                |
| 33  | <i>X. emertoni</i> , epigynum                                    | 34                             |
| 35  | <i>X. ferox</i> , retrolateral view                              | 36                             |
| 37  | <i>Xysticus fraternus</i> , male palpus, ventral view            | <i>X. ferox</i> , epigynum     |
| 38  | <i>X. fraternus</i> , retrolateral view                          | 39                             |
|     |  | <i>X. fraternus</i> , epigynum |

brown dots. The legs have narrow light dorsal stripes with numerous brown dots and larger spots. The male is more distinctively colored. The central cephalothoracic stripe extends from the clypeus to the beginning of the posterior declivity. The remainder of the cephalothorax is reddish brown more or less streaked with yellow. The legs are darker than in the female with a few light spots. Dorsally the abdomen has a series of conspicuous light crossbars and less distinct central and dorsolateral stripes roughly blocking out five pairs of dark spots which diminish in size posteriorly. The epigynum (Fig. 33) is a heavily chitinized structure with its main part distinctly divided into a shallow posterior half and a deeply excavated anterior half. The pits which have been interpreted as the openings to spermathecae are within the main area of the epigynum and are very close together, sometimes being actually united. Two conspicuous black spots lie just posterior to the epigynum. The male palpus (Figs. 31-32) has its tarsal apophyses greatly elongated and pointed prolaterally. The anterior apophysis overlies the other one to some extent. The dorsal lateral tibial apophysis is about half as long as the tarsus; the ventral apophysis is a short stout extension with a distinct retrolateral ridge. Both apophyses are somewhat excavated along the distal margin.

### *Xysticus ferox* (Hentz)

*Thomisus ferox* Hentz, 1847

*Xysticus stomachosus* Keyserling, 1880

*X. stomachosus* Emerton, 1892.

*X. distinctus* Banks, 1892

*X. transversus* Banks, 1892

*X. ferox* Comstock, 1913

(Figures 34-36)

*Xysticus ferox* is another widely distributed species, believed to occur over the greater part of the United States and much of Canada. I have both sexes from several localities in the vicinity of Albion. The female is a little more than 6 mm. long and the male about 5 mm. The female has a cream-colored patch extending from the posterior row of eyes over the clypeus, where it widens considerably. There is the usual light central cephalothoracic stripe, and in this species a small central dark brown spot occurs just where the posterior declivity begins, with a larger spot on each side of it. The remainder of the cephalothorax has the customary brown, mottled coloration.

The abdomen is darker dorsally, with three pairs of indistinct spots bordered with cream color. The lateral sides and venter are lighter. The legs have the color usual for this genus. The colors of the male are like those of the female except that they are more distinct, especially on the abdomen, where the cream-bordered spots show clearly. The epigynum (Fig 36) is characterized by a simple cavity not usually subdivided by a central septum. In some individuals, however, the presence of a low septum may result in confusing these females with those of *X. elegans*. In the male palpus (Figs 34-35) the anterior tarsal apophysis is a short, obliquely directed organ attached medially; the posterior apophysis an elongated, low, curved structure. The dorsal lateral tibial apophysis is a simple bladelike process when viewed from below, the ventral apophysis is somewhat expanded distally and turned prolaterally as seen from below.

*Xysticus fraternus* Banks

*X. hamatus* Keyserling, 1884 (name preoccupied by Thorell, 1875)

*X. hamatinus* Banks, 1910

*X. fraternus* Bryant, 1930

(Figures 37-39)

Although apparently much less common in its range than several other species in the genus, *Xysticus fraternus* probably is generally distributed all over the region east of the Rocky Mountains and in the Southwest. A few examples of both sexes have been taken in Michigan in the vicinity of Albion. Females are about 5.5 mm. long and males about 4.25 mm. The female is among the lighter-colored members of this genus. There is a light-colored band between the rows of eyes and the light central cephalothoracic stripe extends from the eyes to the posterior margin. Elsewhere the cephalothorax is pale brown somewhat mottled with yellow. The dorsal area of the abdomen is pale brown with cream-colored broken stripes and bars and with a few brown spots toward the posterior end, the lateral sides are darker. The first two pairs of legs are distinctly darker than the others. The markings in the male are similar but the colors are much more distinct. The cavity of the epigynum (Fig 39) is clearly divided into two smaller lateral depressions by a low, broad, but very distinct septum. Near the anterior border are two very small, faintly outlined depressions. The oval openings of the sper-

mathecae are separated by a distance equal to a little less than twice the length of one of them. The male palpus (Figs 37-38) is very different from all others which I have examined. A long flat plate extends somewhat obliquely across the tarsus. The anterior tarsal apophysis is reduced to a small obtuse tubercle, whereas the posterior one is elongated and extended obliquely. Both palpal tibial apophyses are simple processes, the dorsal one having a sharp distal edge and the ventral one being very blunt distally. Both are somewhat excavated retrolaterally.

*Xysticus funestus* Keyserling

*X. brunneus* Banks, 1892

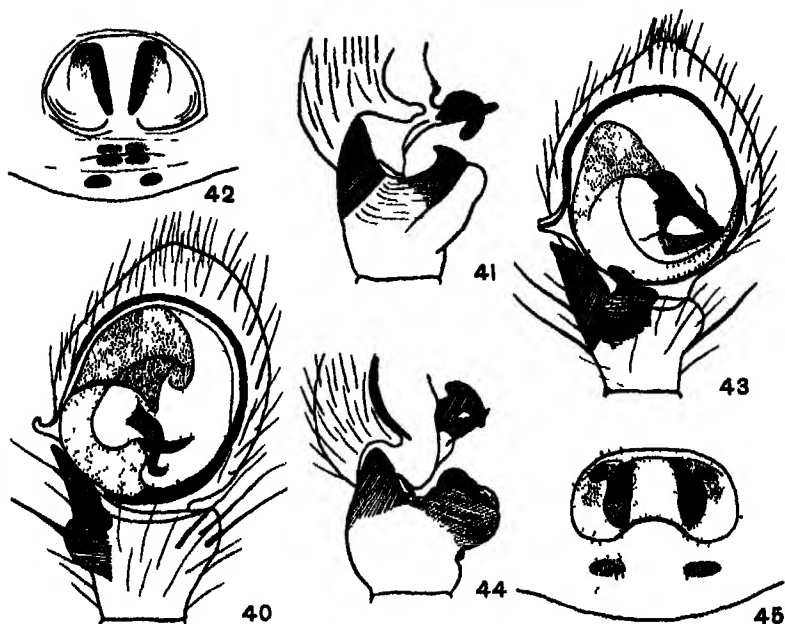
*X. crudelis* Banks, 1892

*X. nervosus* Banks, 1892

*X. nervosus* Comstock, 1913

(Figures 40-42)

In my examination of Banks's types and of several of Emerton's specimens I have been much puzzled in regard to the identification of the females. I am now inclined to believe that Gertsch (1934) has correctly synonymized the group. The folds in the epigynum seem to be variable, and this is the decisive point in making determinations. The species extends from northern New England southward along the Atlantic Ocean to Florida, and westward to Illinois, Missouri, and New Mexico. A few specimens of both sexes have been collected in the vicinity of Albion. Females are about 7 mm long and males about 3.5 mm. Females have a broken light-colored band between the rows of eyes. The markings of the cephalothorax are much as usual in this genus except that they are lighter and have less differentiation. Dorsally the abdomen is a dirty brown, with small light-colored dots. The legs are somewhat lighter than usual. The male is generally paler than the female, the abdomen is yellow dorsally rather than brown, on the hinder half there are three or four dark bars bordered in front with white. In my specimens the epigynum (Fig 42) consists of a cavity which is about two thirds as long as wide. Two folds converging posteriorly are the chief features of this organ. Unfortunately, however, these folds seem to vary in the degree to which they are developed and may be almost entirely lacking. Because of this circumstance care must be taken in making determinations. The male palp (Figs 40-41) is so distinctive that



## EXTERNAL ANATOMY OF SPIDERS

(Figures 40-45)

- 40 *Xysticus funestus*, male palpus, ventral view
- 41 *X. funestus*, tibia and base of tarsus, retrolateral view
- 42 *X. funestus*, epigynum
- 43 *Xysticus graminis*, male palpus, ventral view
- 44 *X. graminis*, tibia and base of tarsus, retrolateral view
- 45 *X. graminis*, epigynum

little difficulty will be found in identification. Both tarsal apophyses are elongated, the anterior one overlying and, to some extent, twisting about the posterior one. The dorsal lateral tibial apophysis is a simple, somewhat elongated, bladelike process, the ventral apophysis is bulbous at the base and constricted toward the distal end, which is narrowed and obliquely extended into a beaklike process when seen from below.

*Xysticus graminis* Emerton

(Figures 43-45)

*Xysticus graminis* is known from New England to Alabama, and westward to Iowa. My collection from Michigan contains only one



mature individual, a male from Albion. This male is 3.75 mm. long, females are about 6 mm. long. The male has a white band between the two rows of eyes. The central light cephalothoracic stripe is less distinct than usual; two whitish lines extend posteriorly from close to the posterior lateral eyes, and unite just where the posterior declivity begins. The usual dark lateral sides of the cephalothorax are divided by light stripes, so that the whole is supplied with seven rather indistinct stripes, four dark and three light. Dorsally the abdomen is dark-colored, with an indistinct broad light central patch, behind this patch is a series of broad dark bars separated by narrow light lines. Laterally and, to some extent, ventrally the abdomen is decorated with alternate light and dark stripes. The female is colored like the male except that all the markings are less intense and, frequently, the whole dorsum takes on a whitish cast. The cavity of the epigynum (Fig. 45) is about twice as wide as long. It encloses two stout folds which usually diverge very slightly at their posterior ends and lie about twice the width of one of them apart. The anterior male palpal tarsal apophysis (Figs. 43-44) is attached medially, extends obliquely across the bulb, and slightly overlaps the posterior apophysis, which is a slender spine turned a little away from the tibia. The dorsal tibial apophysis is a simple blade-like extension; the ventral apophysis is differentiated distally into three short processes, one of these, when seen from below, closely resembling a corresponding process on the tibia of *X. funestus*.

*Xysticus gulosus* Keyserling

*X. lentus* Banks, 1892

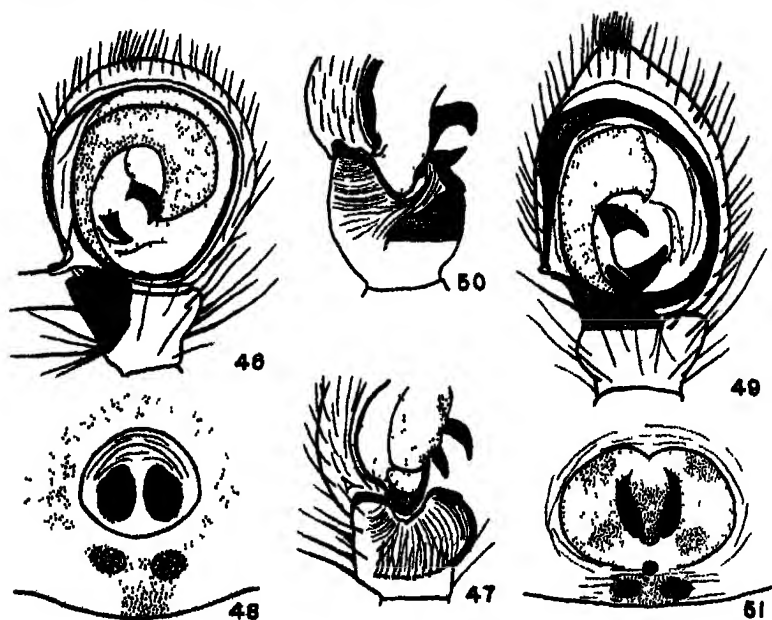
*X. gulosus* Banks, 1892.

*X. gulosus* Comstock, 1913

(Figures 46-48)

This species is believed to be quite generally distributed over the whole of the United States and over much of Canada. I have it in my Michigan collection from several localities in both peninsulas. It is one of our largest species: females average about 7.5 mm. in length and males about 5 mm. or a little less. The presence of fine brown dots on a yellowish background gives a grayish brown color to the females. Fairly large curved spines tend to be arranged in distinct rows, especially on the abdomen. The median light cephalothoracic stripe is paler than usual and includes a central dark spot

at the beginning of the posterior declivity. The posterior end of the median stripe is almost white, with a narrow white lateral marginal line. The abdomen usually has a series of dorsal light bands on the posterior half, but sometimes the whole dorsum is white. The legs prominently display the dorsal light stripes, dark stripes often occur also. The underparts are all light brownish gray. The male is more deeply colored but its markings are otherwise similar. The epigynum (Fig. 48) renders identification of females easy. Its shallow cavity is nearly as long as wide, and it has two large swollen folds, lying close together, as its most distinctive features. The spermathecae are a little less than the length of one of them apart. The



## EXTERNAL ANATOMY OF SPIDERS

(Figures 46-51)

- 46 *Xysticus gulosus*, male palpus, ventral view
- 47 *X. gulosus*, tibia and base of tarsus, retrolateral view
- 48 *X. gulosus*, epigynum
- 49 *Xysticus triguttatus*, male palpus, ventral view
- 50 *X. triguttatus*, tibia and base of tarsus, retrolateral view
- 51 *X. triguttatus*, epigynum

two male palpal tarsal apophyses (Figs 46-47) are slender clawlike structures somewhat directed toward each other. The lateral tibial apophyses are about equal in length, the tibia being deeply excavated between them, the ventral apophysis is strongly recurved along its distal edge.

*Xysticus triguttatus* Keyserling

*X. feroculus* Banks, 1892

*X. triguttatus* Emerton, 1892

*X. triguttatus* Comstock, 1913

(Figures 49-51)

Both sexes of this species are represented in my Michigan collection, but all the specimens are from the Northern Peninsula and the region around the University of Michigan Biological Station at Douglas Lake. It is probably not a very common species although it is known to have a wide distribution, from Nova Scotia southward to Virginia and westward as far as Colorado and Texas. Females are about 5 mm long and males a little less than 4 mm. The sexes differ greatly in general appearance. Females have a brownish yellow cephalothorax, a white eye space, and two whitish lines curving inward from between the posterior median and the posterior lateral eyes and uniting at a dark spot which lies just at the beginning of the posterior declivity. The lateral dark cephalothoracic stripe on each side is partly divided by a lighter stripe. The abdomen is nearly white dorsally and usually has a pair of small black spots near the base and a series of three or four pairs of black spots incompletely united transversely across the posterior half. Comstock's (1913) figures of this species are good for reference. The legs are an amber color. The male is one of the most attractive members of the genus. The first three segments of the first two pairs of legs are a rich mahogany brown, all the remaining segments are yellowish, as are the two posterior pairs of legs. These latter pairs of legs are liberally flecked with brown spots. The cephalothorax is patterned like that of the female but the colors are much deeper. The abdomen is cream color with rich brown spots and bars. The epigynum (Fig 51) is about two thirds as long as wide. Its cavity contains two thin folds partly enclosing a rather deep channel and lying about as far apart at their posterior ends as the width of one of them. The male palpal tarsus (Figs 49-50) has a very heavy embolus and a conductor

which almost complete a circle around the periphery of the bulb. The two clawlike tarsal apophyses are directed prolaterally and turned a little toward each other. The dorsal lateral tibial apophysis is recurved at its distal edge, the ventral apophysis is constricted distally and directed obliquely in a beaklike process. Both apophyses are considerably excavated retrolaterally.

## PHILODROMINAE

### KEY TO THE GENERA OF PHILODROMINAE

- 1 Second pair of legs much longer than first pair, posterior row of eyes gently recurved, median ocular quadrangle only a little wider behind than in front *Ebo*, p. 217
- 1 Second pair of legs little if any longer than first pair, posterior row of eyes rather strongly recurved, median ocular quadrangle much wider behind than in front 2
- 2 Body long and slender, abdomen cylindrical, cephalothorax much longer than wide, posterior lateral eyes somewhat isolated from all others *Tibellus*, p. 232
- 2 Body shorter and broader, abdomen more or less flattened, cephalothorax nearly as wide as long, posterior lateral eyes not appreciably isolated 3
- 3 Posterior median eyes closer to posterior laterals than to one another, second pair of legs a little longer than first pair, first pair of legs a little longer than fourth pair *Philodromus*, p. 219
- 3 Posterior median eyes closer to one another than to the posterior laterals, fourth pair of legs longer than first pair *Thanatus*, p. 231

### GENUS *EBO* KEYSERLING, 1883

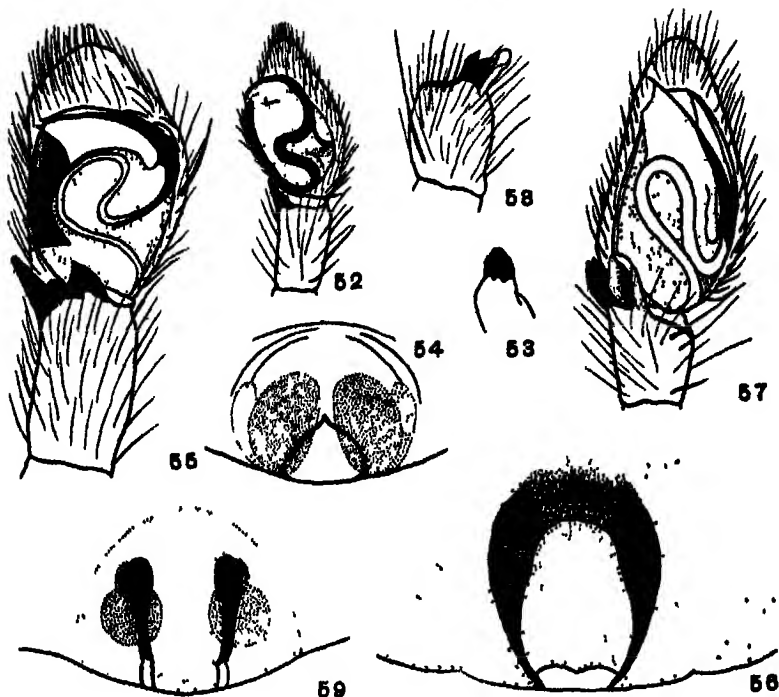
#### *Ebo latithorax* Keyserling

*E. latithorax* Emerton, 1892

*E. latithorax* Comstock, 1913

(Figures 52-54)

This species, one of the smallest of the Thomisidae, is quite well known from New England southward to Virginia and westward to Michigan. I have collected it only three times in Michigan, always from siftings in the vicinity of Albion. I found it once in leaf litter taken from beneath the snow in January, once in April, and once in May; all my specimens were immature. Little is known of the life of this species. Mature females are about 3 mm long and males about 2.5 mm. The sexes have essentially the same coloration. The cephalothorax is a reddish yellow with dark brown irregular lines.



## EXTERNAL ANATOMY OF SPIDERS

(Figures 52-59)

- 52 *Ebo latithorax*, male palpus, ventral view
- 53 *E latithorax*, part of the tibia, retrolateral view
- 54 *E latithorax*, epigynum
- 55 *Philodromus aureolus*, male palpus, ventral view
- 56 *P aureolus*, epigynum
- 57 *Philodromus exilis*, male palpus, ventral view
- 58 *P exilis*, tibia, retrolateral view
- 59 *P exilis*, epigynum

radiating from the region of the thoracic furrow. The posterior row of eyes is almost straight or very gently recurved. The abdomen is brownish yellow somewhat flecked with irregular brown spots. There are several indistinct chevron-like bars across the posterior half of this part of the body. The epigynum (Fig 54) is very simple, with a central somewhat depressed area just in front of the genital groove and with two large oval spermathecae lying close together. The male

palp (Figs 52-53) has a single simple tibial apophysis and a serpentine tube leading to the short evenly curved embolus

### GENUS PHILODROMUS WALCKENAER, 1825

This genus contains the bulk of our Philodrominae, it is a very large genus, rivaling *Xysticus* in the number of its species. Petrunkevitch (1911) listed thirty-eight species for the Western Hemisphere, Comstock (1913) stated that thirty were known for the United States; Berland and Fage (1932) recorded eighteen for France, many new species have been described in recent years. In this genus the posterior row of eyes is moderately recurved, the posterior median eyes are closer to the posterior laterals than to one another, the median ocular quadrangle is much wider behind than in front. The second pair of legs is a little longer than the first pair and the first pair is longer than the fourth. The legs are much longer proportionately in males than in females. The body is flat and broad, the abdomen being somewhat pointed behind. Many of these spiders live on plants, where they are sometimes abundant, but a few spend most of their lives on trees, fences, and buildings. Some are protectively colored and resemble bark, old wood, sand, and the like.

### KEY TO THE SPECIES OF *PHILODROMUS*

#### MALES

- 1 Embolus describes more than a semicircle around the bulb, tube forms a loop directed transversely prolaterally; palpal tibia about as wide as long (exclusive of the apophyses) 2
- 1 Combination of features of embolus, tube, and palpal tibia not as above 3
- 2 Ventral lateral tibial apophysis a long leaflike membranous process, dorsal apophysis a much shorter, stouter process with a distinct distal tooth, directed laterally *P imbecillus*, p 223
- 2 Ventral lateral tibial apophysis a much shorter, slenderer, less membranous process; dorsal apophysis also much slenderer and directed more distally *P mineri*, p 226
- 3 Three distinct tibial apophyses, palpal tibia about twice as long as broad (exclusive of the apophyses); tube of bulb directed retrolaterally *P aureolus*, p 221
- 3 Combination of palpal characters not as above 4
- 4 Embolus describes a semicircle half way around bulb; tube of bulb makes a loop directed longitudinally 5
- 4 Embolus describes much less than a semicircle around bulb, tube of bulb makes a loop directed obliquely 6

- 5 Embolus originates close to ventral lateral tibial apophysis, ventral tibial apophysis a long somewhat blade-like process, dorsal apophysis a small tooth *P marzi*, p 225
- 5 Embolus originates considerably prolateral to ventral tibial apophysis, ventral tibial apophysis a much shorter process, dorsal apophysis longer and somewhat recurved along its distal edge *P rufus*, p 228
- 6 Ventral lateral tibial apophysis a blade-like process which projects retrolaterally at nearly a right angle, dorsal apophysis a simple elongated process distally curved in a ventral direction *P satullus*, p 229
- 6 Ventral lateral tibial apophysis not projecting nearly at a right angle retrolaterally, dorsal apophysis divided distally into two teeth 7
- 7 Ventral lateral tibial apophysis divided distally into two slender teeth, dorsal apophysis short, stout, deeply excavated retrolaterally *P infuscatus*, p 224
- 7 Lateral tibial apophyses not as above 8
- 8 Embolus originates near middle of bulb, curves acutely near its base, palpal tibia nearly twice as long as broad, ventral lateral tibial apophysis a simple well-chitinized process *P perniz*, p 228
- 8 Embolus originates on prolateral margin of bulb, curves gently near its base, palpal tibia not nearly twice as long as broad, ventral lateral tibial apophysis a thin membranous process *P exilis*, p 222

## FEMALES

- 1 Epigynum distinctly longer than wide 2
- 1 Epigynum usually wider than long or at least as wide as long 4
- 2 Epigynum with a broad central piece not much narrowed, a single shallow cavity anterior to broad central piece *P aureolus*, p 221
- 2 Epigynum with a central piece distinctly narrowed, a cavity on each side of central piece 3
- 3 Epigynum with a broad central piece strongly narrowed anteriorly into a distinct septum, a distinct cavity on each side of narrowed septum *P perniz*, p 228
- 3 Epigynum with central piece strongly narrowed just in front of genital furrow, two shallow much-elongated lateral cavities nearly coextensive with central piece *P rufus*, p 228
- 4 Epigynum with three more or less distinct lobes 5
- 4 Epigynum without three more or less distinct lobes 6
- 5 Epigynum with three clearly defined lobes, central lobe wider at base than at apex, no cavities anterior to base of central lobe *P infuscatus*, p 224
- 5 Epigynum with three indistinct lobes, central lobe wider at apex than at base, two shallow oval cavities at base of central lobe *P satullus*, p 229
- 6 Epigynum with a distinct central piece, two shallow cavities either lateral to the central piece or anterior to it and separated from one another by not more than the diameter of one of them 7
- 6 Epigynum without a distinct central piece, shallow cavities always in anterior part of epigynum and farther apart than the diameter of one of them 8

- 7 Epigynum with a central piece more than twice as long as broad, large indistinct oval somewhat depressed areas lateral to central piece  
*P. minor*, p 226
- 7 Epigynum with a central piece less than twice as long as broad, more distinct small oval cavities anterior to base of central piece and about as far apart as the diameter of one of them  
*P. marxi*, p 225
- 8 Cavities of the epigynum farther apart, spermathecae circular, farther from the genital furrow, somewhat smaller species  
*P. exilis*, p 222
- 8 Cavities of the epigynum closer together, spermathecae larger, somewhat oval, closer to the genital furrow, somewhat larger species  
*P. imbecillus*, p 223

*Philodromus aureolus* (Clerck)*Araneus aureolus* Clerck, 1757*P. aureolus* Keyserling, 1880*P. canadensis* Emerton, 1917

(figures 55-56)

This appears to be the most common *Philodromus* in Michigan, and I have many specimens of both sexes from both the Northern and Southern peninsulas. The species is common throughout most of Canada, the United States, and Europe, where several varieties are recognized. Females are a little less than 5 mm long and males about 4 mm. Females have a light-colored central cephalothoracic stripe, about as wide as the eye group, extending from the anterior eyes to the posterior border of this part of the body. The lateral sides of the cephalothorax are reddish brown, with a little yellow along the margin. The abdomen is slightly lobed at its base. Its ground color is a very light yellow, there is a reddish brown lanceolate stripe at the base, and much of the remaining area is reddish brown. The lateral sides have some darker brown. The underparts are all light-colored. The legs have some of the reddish brown color, which is intensified at the distal ends of many of the segments. The color pattern of the male is like that of the female but is much more clearly outlined. The epigynum (Fig 56) is very distinctive, consisting of a broad central piece flanked on either side by a narrow dark-colored somewhat curved piece. There is a central shallow cavity just anterior to the central piece. The male palpus (Fig 55) has its patella longer than its tibia (exclusive of the apophyses). There are three tibial apophyses, the ventral one being a stout bladelike process, the intermediate one a small tooth, and the dorsal one a long strong process somewhat flattened apically.



*Philodromus exilis* Banks*P. bidentatus* Emerton, 1892

(Figures 57-59)

In my collection of Michigan spiders I have both sexes of *Philodromus exilis* from a few localities in the Southern Peninsula but neither from the Northern Peninsula. It is probably not a very common species, although it is known from Nova Scotia along the Atlantic region as far south as Virginia and westward to New Mexico. Both sexes are about 3.5 mm long. In females the light-colored median cephalothoracic stripe is bright yellow. It includes the eye space and the whole clypeus. The lateral sides of the cephalothorax are a dark walnut brown speckled a little with dull yellow and there is a little yellowish color along the lateral margin. The abdomen is slightly lobed at its base. There is a fairly clear basal central lanceolate stripe. The lateral sides of the abdomen are brown, about midway this color extends dorsally and shows faintly across the dorsal surface, often making a very distinctive mark. Incomplete light and dark chevrons occur on the posterior half. The underparts are all yellowish. The legs are yellowish somewhat dotted with brown. The males in my collection are all much less brightly colored than the females. The central light cephalothoracic stripe has a good deal of brown in it and does not include the clypeus. Dorsally the abdomen shows very little of the bright colors of the female; the fundamental pattern is present but is obscured by the greater amount of colored surface. The epigynum (Fig. 59) is very simple, consisting essentially of a low mound with two small crescentic cavities more than twice the length of one of them apart and about as far from the genital furrow as they are separated from one another. Faint lines or ridges connect the cavities with the posterior margin and these lines converge slightly just in front of the genital furrow. The male palpus (Figs. 57-58) is quite distinctive. The patella is longer than the tibia (exclusive of the apophyses) in the ratio 4:3. The tibia is a little longer than it is broad. The ventral lateral tibial apophysis is a blunt somewhat membranous process; the dorsal apophysis is a stout well-chitinized structure bidentate apically. The embolus arises on the prolateral side and gently curves near its base, the loop of the tube originates near the base of the bulb and is directed somewhat obliquely.

*Philodromus imbecillus* Keyserling*P. lineatus* Emerton, 1892*P. carolinus* Banks, 1911

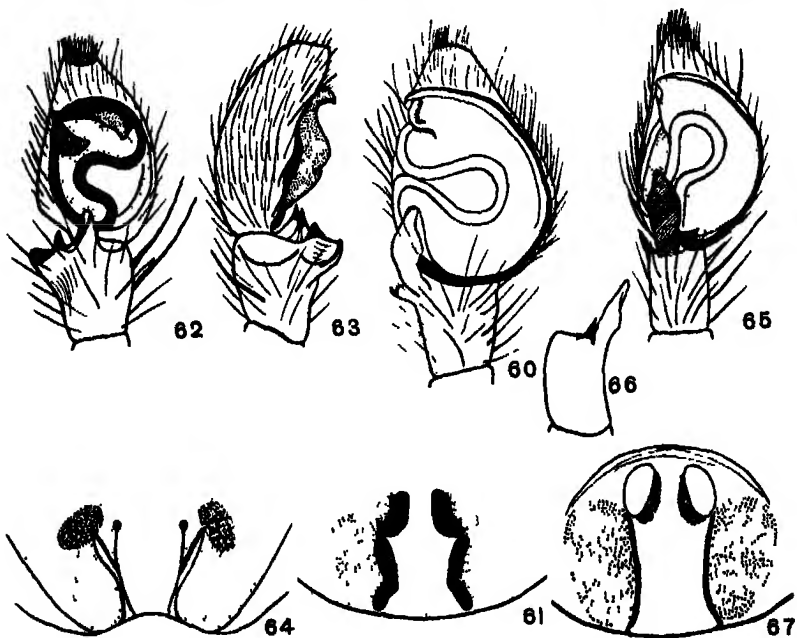
(Figures 60-61)

This species is probably best known from New England but it has a wide distribution as far southward as Florida and westward to the Mississippi River. I have found it abundant in marshy places in the vicinity of Albion and in other localities in the southern part of the state, but I have never found it elsewhere. Females are about 4.25 mm. long and males about 3.3 mm. Emerton's name for this species was well chosen, because its conspicuous oblique abdominal lines give it considerable distinction. Ordinarily in females the median light-colored cephalothoracic stripe begins with the clypeus and continues broadly to the posterior margin. The lateral sides of the cephalothorax are reddish brown with a slightly yellowish margin. The abdomen is white dorsally with a reddish brown basal lanceolate stripe and a series of five or six pairs of oblique reddish brown bars across the posterior two thirds. The lateral sides are usually supplied with much of the reddish brown color. Quite frequently, however, the brown may be nearly lacking and the dorsal area almost pure white. The legs are light reddish brown with a strong tendency toward light and dark stripes. Males are much darker in color and many show very little of the striking pattern of the female. The epigynum (Fig. 61) is very similar to that of *Philodromus exilis*. There are two small cavities less than the length of one of them apart and farther from the genital groove than they are from one another. The posterior boundaries to the central part diverge slightly just before meeting the genital furrow. The spermathecae are large, oval, and separated from one another by the width of the central part of the epigynum. The patella of the male palpus (Fig. 60) is longer than the tibia in the ratio of 14.9. The embolus originates on the retrolateral side of the bulb; the loop arises from the retrolateral side and is directed transversely. The ventral lateral tibial apophysis is nearly as long as the tibia, somewhat flattened, and membranous; the dorsal apophysis is short, broad at its base, and toothed distally.

*Philodromus infuscatus* Keyserling*P. unicolor* Banks, 1892*P. macrotarsus* Emerton, 1917

(Figures 62-64)

Of this species from Michigan I have but two specimens, both females. One is from Old Mission, the other from Albion. The species is known from Ontario, Canada, New York, Virginia, Maryland, and Michigan. It is probably not a very common species.



## EXTERNAL ANATOMY OF SPIDERS

(Figures 60-67)

- 60 *Philodromus imbecillus*, male palpus, ventral view
- 61 *P. imbecillus*, epigynum
- 62 *Philodromus infuscatus*, male palpus, ventral view
- 63 *P. infuscatus*, male palpus, retrolateral view
- 64 *P. infuscatus*, epigynum
- 65 *Philodromus marzi*, male palpus, ventral view
- 66 *P. marzi*, tibia, retrolateral view
- 67 *P. marzi*, epigynum

anywhere, but it is likely to be widely distributed. In females the abdomen is quite noticeably bilobed at the base. The general coloration is gray. The cephalothorax lacks the median light stripe, and just behind the eyes there is a poorly defined dark spot. The clypeus is unusually swollen in this species. The abdomen is gray with faint darker oblique bars across the posterior half and along the lateral sides. The legs are yellowish, with small irregularly arranged dark spots. The underparts are all very light-colored. The general coloration of the male is similar to that of the female, but the colors are duller and less distinctive. The epigynum (Fig. 64) is quite unlike that of any other I have seen among the philodromids. There are three well-defined lobes, the openings are apparently at the anterior ends of the slits separating the median lobe from the two lateral lobes. In the male palpus (Figs. 62-63) the tibia is a little wider than long because the dorsal apophysis is extended so far laterally. The patella is about as long as the tibia. The ventral lateral tibial apophysis is turned toward the tarsus and bifurcated distally into parallel pointed processes, the dorsal apophysis is a stout, laterally extended, and deeply excavated process. The embolus originates near the anterior end of the bulb and curves gently to its termination, the loop arises on the prolateral side of the bulb near the base and is directed somewhat obliquely across it.

*Philodromus marxi* Keyserling

*P. ornatus* Banks, 1892

*P. minusculus* Banks, 1892

(Figures 65-67)

Although this species is now known from several localities all the way from New England southward to North Carolina and westward as far as Texas and, possibly, even as far as California, I have only one mature individual, a female, from southern Michigan. It is regarded as a rather uncommon species. Females are among our most clearly marked philodromids. The clypeus is a light dusty brown. The usual central cephalothoracic light-colored stripe begins with the eye space and continues to the posterior border. The lateral sides of the cephalothorax are a rich walnut brown. The abdomen is nearly all white dorsally, the lateral sides are dark brown, and about midway these colored regions extend dorsally, as noted in Banks's original description. The legs and the underparts are

a light yellowish color. It has been impossible to examine freshly preserved males, but those long in alcohol show little of the light coloration so characteristic of females. The light cephalothoracic stripe is indistinct, and apparently the abdomen is quite completely covered with a light brown color. The epigynum (Fig. 67) has a central piece resembling that of *Philodromus mineri*, though it is less elaborate. The cavities are small and lie anterior to the central piece. In the male palpus (Figs. 65-66) the patella is about as long as the tibia. The embolus originates at the proximal end of the tarsus, turns acutely near its base, and curves gently to its termination. The loop also originates near the base of the tarsus and is directed longitudinally instead of nearly transversely as in *P. mineri*. The ventral lateral tibial apophysis is a long, rather broad, somewhat membranous process. The dorsal apophysis is a sharp tooth of moderate size.

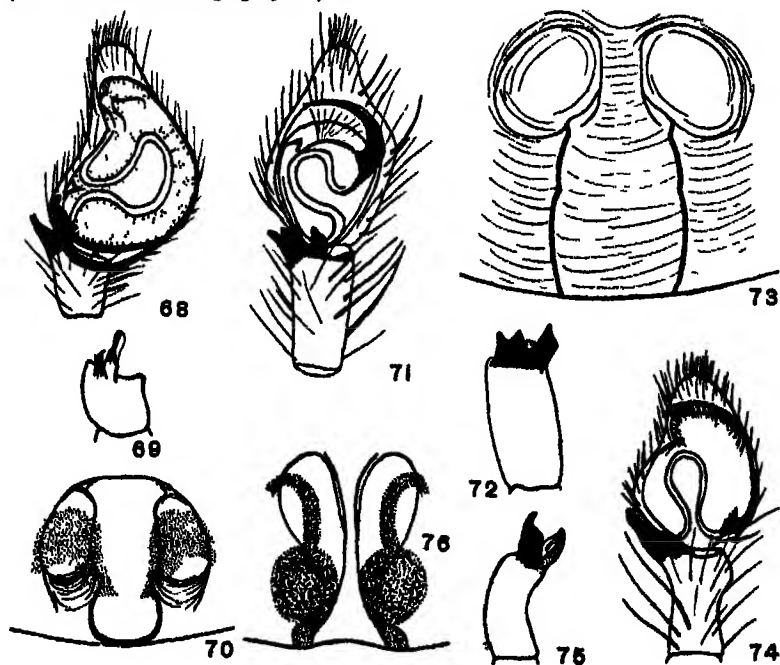
*Philodromus mineri* Gertsch

*P. emertoni* Bryant, 1933

(Figures 68-70)

Dr. Gertsch's type came from Douglas Lake, Michigan. Miss Bryant's type came from a collection which belonged originally to Mr. J. H. Emerton and which he obtained from North Carolina. Though little is known about the species it is believed to be widely distributed over the country east of the Rocky Mountains. It is not likely to be a very common species except, perhaps, locally. I have collected mature individuals only once in Michigan, in the vicinity of Albion. Females are about 4.5 mm long and males about 3.5 mm. In females the light-colored median cephalothoracic stripe is very broad and includes the eyes and the whole clypeus. The lateral sides are a reddish brown with a little yellow along the margin. The abdomen is somewhat bilobed at its base. Dorsally it is all light-colored, with a few brown flecks and indistinct light oblique bars across the posterior half. The legs are all light yellowish with a few brown flecks here and there. The underparts are all light yellowish dotted a little with brown. The epigynum (Fig. 70) has a well defined central piece with a large oval area (which I consider to be a shallow depression) on each side. The embolus of the male palpus (Figs. 68-69) originates close to the ventral lateral tibial apophysis and curves rather acutely at first, and then more gently,

to its termination; the loop arises on the retrolateral side and lies nearly transversely across the bulb. The ventral lateral tibial apophysis is a membranous process, somewhat elongated and extending in close contact with the tarsus considerably beyond the origin of the embolus; the dorsal apophysis is a well-chitinized, elongated process, bifurcated distally into a short denticle and a longer hooklike extension. The patella is slightly longer than the tibia (exclusive of the apophyses)



## EXTERNAL ANATOMY OF SPIDERS

(Figures 68-76)

- 68. *Philodromus mineri*, male palpus, ventral view
- 69. *P. mineri*, tibia, retrolateral view
- 70. *P. mineri*, epigynum
- 71. *Philodromus pernax*, male palpus, ventral view
- 72. *P. pernax*, tibia, retrolateral view
- 73. *P. pernax*, epigynum
- 74. *Philodromus rufus*, male palpus, ventral view
- 75. *P. rufus*, tibia, retrolateral view
- 76. *P. rufus*, epigynum

*Philodromus pernix* Blackwall*P. vulgaris* Emerton, 1892*P. pernix* Comstock, 1913

(Figures 71-73)

This is another species which is believed to be distributed over most of the United States and much of Canada. It is one of our most common philodromids in southern Michigan, but I have not collected it in the Northern Peninsula. Females are about 5.25 mm long and males about 4 mm. Emerton's (1902) figures are good for the form and color pattern of this species. In females the usual median light stripe and the dark lateral sides are present on the cephalothorax. Two white bands unite behind the eyes to make a procurved figure. The abdomen has a more or less distinct basal central lanceolate stripe and the posterior two thirds of the dorsum bears a herringbone pattern of alternate light and dark bars. The lateral sides are dark brown and the underparts are all light-colored. The legs are yellowish spotted with brown. In life these spiders are often coated with a fairly thick covering of hair which obscures the color pattern. The coloration of the male is much the same as that of the female except that it is dull and indistinct. The epigynum (Fig. 73) has a prominent central piece which is strongly narrowed anteriorly, on each side of the narrowed part is a prominent cavity. Frequently these cavities are filled with a hard transparent substance and are, therefore, more or less obscured. The tibia of the male palpus (Figs. 71-72) is distinctly longer than its patella. The embolus arises near the anterolateral side, curves acutely near its base and then evenly to its termination. The loop originates on the prolateral side and is directed in an oblique direction across the bulb. The ventral lateral tibial apophysis is a simple stout tooth, the dorsal apophysis is a flat blade-like process bifurcated distally into sharp teeth.

*Philodromus rufus* Walckenaer*P. pictus* Emerton, 1892

(Figures 74-76)

*Philodromus rufus* Walckenaer has a very wide distribution over the whole of the United States, much of Canada, and most of Europe. I have mature females from both Michigan peninsulas but no mature

males, yet I consider the species fairly common in the state. Females are about 4.5 mm long and males a little smaller. The median cephalothoracic stripe is very light yellow, the lateral sides of the cephalothorax reddish brown. The abdomen is yellowish along the median dorsal region but laterally it is reddish brown. Faint oblique bars show across the posterior half of this part of the body. The underparts are all light yellowish and the legs are yellowish with small brown dots irregularly distributed over them. The male is colored like the female except that it is much darker and has less pattern. The epigynum (Fig 76) has a long central piece which is strongly narrowed just a little in front of the genital groove. On each side of the central piece is a long slender shallow cavity. The male palpal tibia is strongly curved dorsally (Fig 75) and is a little longer than the patella. The embolus (Fig 74) arises considerably prolateral to the ventral lateral tibial apophysis, the loop originates at the base of the bulb and is directed longitudinally. The ventral lateral tibial apophysis is shorter (foreshortened in the figure because of position in which it was viewed) than the dorsal apophysis, and quite membranous, the dorsal apophysis is longer, well chitinated, and apically produced into a distinct hook.

*Philodromus satullus* Keyserling

*P. minutus* Banks, 1892

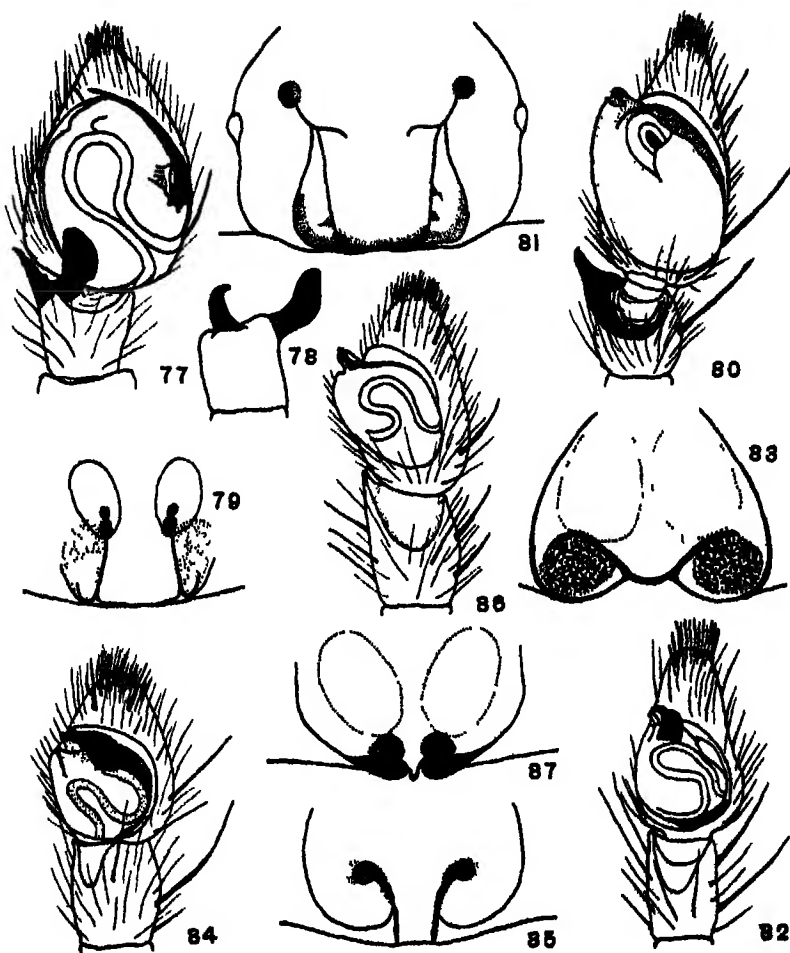
*P. brevis* Emerton, 1892

*P. minutus* Comstock, 1913

(Figures 77-79)

This species is represented in my Michigan collection by immature females and one mature male, all collected in the vicinity of Albion. It is probably not a very common species anywhere, but it is now known from numerous localities in New England, New York, the middle western states, and the far west as far as Washington and California. Females are about 4 mm long and males about 3.25 mm. The cephalothorax of the females has the usual light median stripe and dark lateral sides. A procurved patch of white occurs just behind the eyes. A dark median basal dorsal abdominal stripe is fairly distinct, and a less distinct dark bar may be observed across the middle of the abdomen. The dorsolateral sides are dark reddish brown, and there are light bars across the posterior third of the abdomen. The legs are generally dark brown with some indi-





## EXTERNAL ANATOMY OF SPIDERS

(Figures 77-87)

- |   |                                  |
|---|----------------------------------|
| 77. <i>Philodromus satullus</i> , male palpus, ventral view | 79 <i>P. satullus</i> , epigynum |
| 78. <i>P. satullus</i> , tibia, retrolateral view           |                                  |
| 80. <i>Thanatus formicinus</i> , male palpus, ventral view  |                                  |
| 81. <i>T. formicinus</i> , epigynum                         |                                  |
| 82. <i>Tibellus duttoni</i> , male palpus, ventral view     | 83 <i>T. duttoni</i> , epigynum  |
| 84. <i>Tibellus maritimus</i> , male palpus, ventral view   |                                  |
| 85. <i>T. maritimus</i> , epigynum                          |                                  |
| 86. <i>Tibellus oblongus</i> , male palpus, ventral view    | 87 <i>T. oblongus</i> , epigynum |

cations of stripes. The colors of the male are less distinct but are otherwise like those of the female. The epigynum (Fig. 79) is indistinctly divided into three lobes near the genital furrow, the central piece being about as long as wide and having two shallow oval cavities just anterior to it and separated from one another by less than the diameter of one of them. In the male palpus (Figs 77-78) the embolus originates on the prolateral side of the bulb and is gently curved at its base, the loop arises at the prolateral basal corner and is directed obliquely across the bulb; the ventral lateral tibial apophysis is a bladelike membranous process which projects almost at a right angle; the dorsal apophysis is a well-chitinized process curved ventrally into a distinct hook.

#### GENUS *THANATUS* C. KOCH, 1837

##### *Thanatus formicinus* (Clerok)

*T. lycosoides* Emerton, 1892

*T. lycosoides* Comstock, 1913

*T. formicinus* Simon, 1932

*T. canadensis* Gertsch, 1933

(Figures 80-81)

There appears to be only one species of *Thanatus* in Michigan, although Kaston (1938) recently recognized two in Connecticut. Mature individuals of both sexes are in my collection from the two Michigan peninsulas, and I regard *T. formicinus* as fairly common in the state. In the past there has been much confusion regarding *Thanatus* in the United States. Emerton himself synonymized *T. lycosoides* with *T. coloradensis* Keyserling. Petrunkevitch (1911) did the same thing, and for thirty years the two were regarded as the same species. Recently, through the publications of Gertsch (1933, 1934) and through further work by Miss Bryant on the collections in the Museum of Comparative Zoölogy, the status of the species which we have in this country has been clarified. It is now known to be widely distributed over the northeastern part of the United States, eastern Canada, and most of Europe. Mature females are about 8 mm. long and males only a little smaller though their legs are longer. The cephalothorax is very slightly longer than broad, and the whole body is well supplied with a coating of hair. The posterior row of eyes is strongly recurved; the posterior median

eyes are a little closer to one another than to the posterior laterals; the anterior laterals are closer to the anterior medians than they are to the posterior medians, and the ocular quadrangle is much wider behind than in front. The coloration is essentially the same in the two sexes and recalls the general coloration of many of the Lycosidae. The cephalothorax has a median light stripe from the anterior eyes to the posterior margin, but this light stripe includes within it a shorter and smaller stripe from the posterior eyes back to the region of the thoracic furrow. Comstock's figures (1913) will help beginners to fix the essential facts concerning the form and color pattern of this species in their minds. The lateral sides of the cephalothorax are a dark brown more or less broken by a lighter stripe which lies near the lateral margin. The brownish abdomen has a conspicuous black basal dorsal lanceolate stripe extending a little more than half its length. The legs are generally dark brown, but there are prolateral and retrolateral femoral stripes. The epigynum (Fig 81) is somewhat broader than long, and there is a broad central scutiform depression within which lies a broad flat, distally spatulate septum. The male palpus (Fig 80) has a swollen bulb obliquely placed in the tarsus and a simple massive tibial apophysis.

#### GENUS TIBELLUS SIMON, 1875

In this genus the whole body is long and slender; the cephalothorax is much longer than broad and the abdomen is very long and cylindrical. These spiders are usually light yellowish (sometimes reddish), with dark brown stripes and spots. They are the largest of our philodromids and are usually found on low bushes, weeds, and grasses. The posterior row of eyes is so strongly recurved that the eyes nearly form a semicircle, the anterior eyes and the posterior medians are grouped together in such close proximity that the posterior laterals are left somewhat isolated. The median ocular quadrangle is much wider behind than in front, the posterior median eyes are much nearer one another than they are to the posterior laterals. The American species of *Tibellus* have been in much confusion until recently, when Miss Bryant (1933) and Gertsch (1933) together greatly clarified their status. Three species have been reported from Michigan; I am including all of them in this paper, even though I have not collected *T. duttoni* in the state.

Gertsch (1933) has given careful technical descriptions of the three species which occur in our region

KEY TO THE SPECIES OF *TIBELLUS*

## MALES

- 1 Anterior tibiae with four pairs of ventral spines; embolus with a distinct distal hook (Fig. 82) *T. duttoni*, p. 233
- 1 Anterior tibiae with three pairs of ventral spines, embolus without a distinct distal hook 2
- 2 Embolus much swollen and coarsely grooved just behind the tip *T. maritimus*, p. 234
- 2 Embolus not swollen just behind the tip, and finely grooved near the apex *T. oblongus*, p. 234

## FEMALES

- 1 Anterior tibiae with four pairs of ventral spines, lateral boundaries of epigynum much more than half as long as broad, constricted anteriorly *T. duttoni*, p. 233
- 1 Anterior tibiae with three pairs of ventral spines, lateral boundaries of epigynum only about half as long as broad, not constricted anteriorly 2
- 2 Width of central piece of epigynum at its posterior end much greater than diameter of openings, openings separated from posterior margin by several diameters *T. maritimus*, p. 234
- 2 Width of the central piece of epigynum about equal to diameter of openings, openings separated from posterior margin by scarcely one diameter *T. oblongus*, p. 234

*Tibellus duttoni* (Hentz)

*Thomisus duttoni* Hentz, 1847

*Tibellus duttoni* Keyserling, 1880

*T. duttoni* Gertsch, 1933

*T. duttoni* Kaston, 1938

(Figures 82-83)

According to Gertsch (1933), this is the spider which Hentz described from Georgia, where it is the most common species. It is found in the southeastern part of the United States from Florida to Texas, and into Mexico, and extends northward into Minnesota and Michigan and eastward to southern New England. Females are about 9.5 mm long and males about 7 mm. Two pairs of dark dorsal spots are usually found at the posterior end of the abdomen. The anterior tibiae have four pairs of ventral spines, whereas each of the other two species in our fauna has but three pairs. The epigynum (Fig. 83) has lateral margins considerably longer than

those of *Tibellus maritimus* and constricted anteriorly; the central piece is very short, and the apertures are close to the posterior margin of the epigynum and relatively far apart. The embolus of the male palpus (Fig 82) is distinctly hooked at its apex

*Tibellus maritimus* (Menge)

*Thanatus maritimus* Menge, 1874

*T. oblongus* Menge, 1874

*Tibellus oblongus* Simon, 1875

*T. maritimus* Kulczynski, 1908.

*T. maritimus* Gertsch, 1933

*T. maritimus* Kaston, 1938

(Figures 84-85)

This species seems to have about the same extensive range as *Tibellus oblongus*, but it is everywhere less common. I have the two sexes in my collection from both peninsulas of Michigan. Females are about 7.3 mm long and males about 6.2 mm. Gertsch (1933) states that it is very difficult, perhaps impossible, to separate this species from *T. oblongus* on the basis of color, body form, leg spines, proportions of the various organs, or the like. The distal black spots on the dorsum of the abdomen are usually lacking. The epigynum (Fig 85) is readily distinguishable from that of any other species in our region. The openings are farther from the genital furrow and the septum is more distinct than in the other species. The lateral boundaries do not extend as far anteriorly nor are they noticeably constricted at the anterior ends. The embolus of the male palpus (Fig 84) is much swollen just behind the apex, and deeply grooved

*Tibellus oblongus* (Walckenaer)

*Aranea oblonga* Walckenaer, 1802.

*Thanatus oblongus* Menge, 1874

*Tibellus oblongus* Keyserling, 1890

*T. duttoni* Emerton, 1892

*T. oblongus* Gertsch, 1933.

*T. oblongus* Kaston, 1938

(Figures 86-87)

This is by far the most common *Tibellus* in Michigan; I have it in my collection from many localities in both peninsulas. It is widely distributed over Europe, Asia, all of southern Canada, the whole of the United States, and, probably, much of northern Mexico. Females are a little less than 8 mm. long and males a little less than

7 mm. In males there are three dark cephalothoracic stripes, one median and two lateral. The intervals between the lateral stripes and the median stripe are light yellow, sometimes dotted with brown or black. The eye tubercles are black. Quite frequently the whole body and the legs acquire a reddish color. The dorsum of the abdomen ordinarily has a median and two lateral brown stripes. At each side of the median stripe near the posterior end of the body is a small black spot. The second pair of legs is the longest. The anterior tibiae have three pairs of ventral spines. Females are colored like the males except that they are usually much lighter. The epigynum (Fig 87) has a very short and narrow septum, the apertures are close together and also close to the posterior margin. The embolus of the male palpus (Fig 86) is finely grooved at the tip and not bulbous as in *T. maritimus* or hooked as in *T. duttoni*. There is also a short tibial apophysis.

ALBION COLLEGE  
ALBION, MICHIGAN

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# LAMPREYS OF THE GENUS *ENTOSPHEMUS* FROM WISCONSIN AND NORTHERN MICHIGAN\*

CHARLES W CREASER

**N**ONPARASITIC brook lampreys of the genus *Entosphenus* are currently designated as *Entosphenus lamottenu* (Le Sueur) by Hubbs and Trautman (1937, p 24) Owing to the seasonal occurrence of the adults of such lampreys records of them are rather rare; hence two collections of some interest are reported here.

The most recent statement of the range of *Entosphenus lamottenu* is given by Greene (1935, p 23), as follows.

Range Minnesota and Iowa, eastward to Connecticut and Maryland, and from northern Michigan, southern Ontario and New York southward to the Illinois and Ohio rivers

Wisconsin collections examined: (1) Big Cr, trib Black R, Monroe Co, (2) Duck Cr, S E Wisconsin Rapids, Wood Co, (3) Coon R, 1 mile S Stoddard, Vernon Co; (4) Otter Cr, trib Lake Koshkonong, Jefferson Co; (5) White Cr, near Easton, Adams Co., (6) Cr at Fall River, Columbia Co

The northernmost points from which this species was collected in Wisconsin are Big Cr, Monroe County, and Duck Cr, Wood County The fact that no records are available for the Great Lakes basin in Wisconsin indicates a Mississippi center of distribution post-glacially, with a southern route of dispersal to Michigan and the east (Chicago and Maumee outlets) The present paucity of records, however, does not justify a conclusion that it failed to use the St. Croix or Fox connectives It is probable that collecting in the early spring will prove *Entosphenus* to be quite common in the Lake Michigan and Lake Superior drainages.

Recently we received a collection of brook lampreys from a creek crossing the country club golf course at Kenosha, Wisconsin, made by Miss M E. Creaser on April 29, 1934 All these are *Entosphenus lamottenu*, and the locality is in the Lake Michigan drainage system

\* Contribution from Wayne University and the University of Michigan Biological Station. This study was aided by the National Youth Administration and the Zoology Research Fund of Wayne University.

It is also of interest to note that this species occurs in the Lake Superior drainage basin, from which it has not hitherto been reported. A specimen was collected by a group of my students on July 4, 1938, from Miner's River, a stream flowing into Lake Superior from Miner's Lake, east of Munising, Michigan (Munising Township, Sec 10, T 47 N, R 18 W). It was one of a group which, to judge from their action, were spawning in this stream a few feet from Lake Superior. It is to be noted that in this species spawning occurs the first of April in the Kenosha and Detroit areas, in early May in the region of Douglas Lake, Cheboygan County, Michigan, and in late June or early July along the southern shore of Lake Superior.

We do not yet have from Lake Superior a specimen of the marine lamprey, *Petromyzon marinus*, which has been spreading in the upper lakes during the past few years and which is now fairly abundant in the northern part of Lake Huron (Hubbs and Pope, 1937).

Louis Agassiz (1850) recorded under the name *Ammocoetes borealis* a lamprey ammocoete found at Michipicoten, Ontario, Canada, on the northeastern shore of Lake Superior. From the description of the dorsal fin of this larval form it certainly is an *Ichthyomyzon*. Since material from the region of Michipicoten is lacking and since both species may be found, it is not possible at this time to tell which of the two species Agassiz collected.

We may, therefore, list as follows the lampreys now known to occur in the Lake Superior watershed.

#### FAMILY PETROMYZONIDAE LAMPREYS

##### I Genus *Ichthyomyzon*

- 1 *Ichthyomyzon unicuspis*, Hubbs and Trautman, northern lamprey  
Mouth of Amicon River, Douglas Co, Wisconsin, Hubbs and Schultz, June 3, 1926, cited by Hubbs and Trautman (1937), p 59, map on p. 44
2. *Ichthyomyzon fossor*, Reighard and Cummins, northern brook lamprey  
Au Train River, Alger Co, V. D. La Baw, June, 1934; cited by Hubbs and Trautman (1937), p 68, map on p. 44.

II Genus *Entosphenus*

3 *Entosphenus lamottenu* (Le Sueur), American brook lamprey

Mouth of Miner's River as it flows into Lake Superior from  
Miner's Lake near Pictured Rocks, State Park, July 4,  
1938

WAYNE UNIVERSITY  
DETROIT, MICHIGAN

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## MORPHOLOGY OF THE IMMATURE STAGES OF SOME NORTHERN MICHIGAN DONACIINI (CHRYSEMELIDAE; COLEOPTERA) \*

CARL E. HOFFMAN

THE Donaciini are a group which has developed unusual adaptations to life in water, particularly in the immature stages. Before any attempt can be made to discuss these adaptations it is necessary to know the structural features which separate the early stages of the different species. This paper, describing the morphology of such stages of eleven species of Donaciini from the Douglas Lake region, Cheboygan County, Michigan, is the first of a series on the general biology of the Donaciini. The remaining parts of the study will deal with the limnological relations of the Donaciini and the respiration of the larvae.

Very little is known about the immature stages of the Donaciini that occur in this country. Only two authors (Sanderson, 1900; MacGillivray, 1903) have made significant contributions to the life histories of American Donaciini. Their investigations, although furnishing much valuable information, are incomplete. Of the eleven species occurring in the Douglas Lake region, five have been considered by these authors. Sanderson described the larvae of *Haemonia nigricornis* Kirby and the eggs and larvae of *Donacia pascatrix* Lacordaire. MacGillivray studied the eggs and larvae of *Donacia cincticornis* Newman and the larvae of *Haemonia nigricornis* Kirby, *Donacia aequalis* Say, and *Donacia subtilis* Kunze. Because their descriptions of the eggs of the species they studied do not conform to those of the author and because their accounts of the larvae are incomplete it is necessary to consider these five species along with the six new ones. The general characteristics of Donaciini larvae have been studied by various persons; Böving (1910) describes and pictures the morphology of larvae of Danish Donaciini.

\* Contribution from the Biological Station and the Department of Zoölogy, University of Michigan.

## SPECIES CONSIDERED

All stages of the species studied were collected by the writer in the vicinity of Douglas Lake. The following species are discussed in this paper.

<i>Haemonia nigricornis</i> Kirby	<i>Donacia quadricollis</i> Say
<i>Donacia piscatrix</i> Lacordaire	<i>Donacia subtilis</i> Kunze
<i>Donacia proxima</i> Kirby	<i>Donacia aequalis</i> Say
<i>Donacia cincticornis</i> Newman	<i>Donacia pubicollis</i> Suffrian
<i>Donacia hirticollis</i> Kirby	<i>Donacia flavipes</i> Kirby
<i>Donacia pubescens</i> Le Conte	

All but one of these species were identified by Mr H S Barber, of the Bureau of Entomology and Plant Quarantine, United States Department of Agriculture, Washington, D C. *Donacia pubicollis* Suffrian was identified by the writer and checked against specimens in the University Museums, University of Michigan, which had been determined by Mr C Schaeffer.

## ACKNOWLEDGMENTS

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## MORPHOLOGY

## GENERAL DISCUSSION

No attempt is made here to discuss any morphological characteristics of the *Donacia* other than those which are of systematic value in separating the eleven species studied. For a detailed account of the complete morphological characteristics the reader is referred to Böving (1910). Before describing the different species the taxonomic characteristics used in this paper will be reviewed. All the following general material and specific descriptions were taken from last larval instars. The first study was made from the exuviae found in the cocoon with the fully formed imago. The characteristics noted were then checked against those larvae which had not formed cocoons.

## LARVAE (Pl II, Figs 13-23)

The length of the larvae at the time of formation of the cocoon ranges from 8-10 mm in *Donacia aequalis* to 13-16 mm in *D. pubicollis*. *Donacia* larvae are either white or cream-colored, those of *Haemonia nigricornis* are green. The larvae have ten abdominal segments, of which the eighth, ninth, and tenth are greatly reduced, except in *D. piscatrix*, *D. cincticornis*, and *D. proxima*. In the eighth abdominal segment the dorsum is equipped with a pair of caudal spines, which the larva may use to penetrate aquatic plants. The size of the caudal spines varies in relation to the rest of the body in the different species, being greatest in *D. proxima*, *D. cincticornis*, and *D. piscatrix*, and comparatively short in all the others. The legs are small and short as compared with the rest of the body in all species except *H. nigricornis*, in which they are usually very prominent. Each leg is composed of three joints and a terminal sclerotized claw, which in all the American forms studied is equipped with a distinct heel and a sickle-shaped part. The curvature of this part and the prominence of the heel vary in general with the species studied, but not sufficiently to be used as specific characters. Nor have specific characters such as MacGillivray (1903) recorded been found in the number of setae on the legs. The head is small and directed forward, either extending free or being completely withdrawn into the prothorax. The general shape of the larvae differs in various species. Some taper gradually anteriorly and posteriorly from the middle of the body, others are not greatly reduced in the sixth and seventh abdominal segments. In *Donacia* the dorsum of the seventh segment is always rounded transversely and is in a dorsal or posterior position. In *H. nigricornis* half of the dorsum of this segment is in a posterior position and the other half is flattened and ventral, as though it were a continuation of the ventral surface (Pl II, Fig 13). The posterior part of this dorsum in *H. nigricornis* is bluntly pointed.

## OCELLI

The ocelli are small spots of black pigment on each side of the parietalia. The usual number is five, arranged in two rows, three in front and two in back. Just before ecdysis the eyes are not visible, which probably explains why MacGillivray (1903) recorded them as wanting in some of the species he described. *Donacia pubescens* has



four ocelli in two rows, two in front and two at the back *D. pubicollis*, *D. piscatrix*, and *D. flavipes* usually have five, but the number and arrangement vary. Within other species the ocelli sometimes vary in number, but in so very few specimens that the eyes can be used as a character when comparing *D. pubescens* with species other than *D. pubicollis*, *D. piscatrix*, and *D. flavipes*.

#### MANDIBLES (Pl. III, Figs. 24-35)

Mandibles are always flat and triangular. The lateral surface is thick and equipped with a distinct beaklike part, which serves as an attachment for the extensor muscle. The beaklike portion is distinct from the remaining lateral surface in all species except *Donacia flavipes*, in which it is a natural continuation of the lateral surface. Curvature of the lateral surface varies, being present to some extent in most species. In *D. flavipes* the lateral surface forms almost a straight line from the point of attachment of the extensor muscle to the proximal part of the outer tooth. There are always two apical teeth, which vary from round to pointed and also vary in their curvature. In most species studied the cutting surface is curved; in *D. flavipes*, however, it is approximately straight. Generally it has a definite concave region just proximad of the inner tooth. This region is serrate in some species and denticulate in others, with the exception of *D. cinchicornis* and *D. proxima*, in which it is either denticulate or smooth. Each mandible has a round condyle, which is always on the basal portion of the ventral side. The basal border of the ventral side between the cutting edge and the condyle varies from straight to curved, when curved, it differs in the location of its concave and convex regions. There are always two setae present, one either on the lateral surface itself or on the beak portion of the lateral surface, the other always on the dorsal surface just distad of the neck of the condyle.

#### FRONTES (Pl. IV, Figs. 47-57)

The frons is always pentagonal. In general, it is not strongly sclerotized except for a band on the anterior edge which continues laterad to form the heavily sclerotized anterolateral border (Pl. IV, Fig. 48, *alb*). The posterolateral edges are without heavily sclerotized bands and unite to form an occipital region (Pl. IV, Fig. 48, *or*), which may be pointed or round, elongated or short. There are five angles: two anterior angles on the inner sides of the heavily sclero-

tized bands at the junctions of the anterior and the anterolateral bands; two lateral angles at the junctions of the anterolateral and posterolateral edges, the lateral ends of the anterolateral sclerotized bands filling a good portion of the angles; one occipital angle, which is formed at the union of the two posterolateral edges. Specific differences occur in the ratio of the distances between the lateral angles and between the occipital angle and mid-anterior point. In some species these distances are approximately equal; in others, one is longer. The occipital region varies in the different species in length and also in the sharpness of the point. The posterolateral margins can be used as specific characters because in the different species they vary from approximately straight to concave or convex. The heavily sclerotized anterolateral border varies in the different species from straight to deeply concave. In certain species the anterior angles differ greatly, in others they are constantly near either  $100^\circ$  or  $120^\circ$ .

#### LABRA (Pl. V, Figs 58-68)

The labrum provides excellent specific characters. It is attached to the distal end of the clypeus, which in turn is attached to the anterior end of the frons. The shape of the labrum varies greatly among the species, although for some it is fairly uniform. There are five sides in all the species except *Donacia flavipes*, in which the lateral and anterior margins form a continuous curve. In *D. hirticollis* the labrum is only weakly five-sided. In the mid-region of the labrum there is a heavily sclerotized band, which bears on its ental surface an anteriorly curved process or hook. The extension of this band toward the posterior point of the labrum varies with the species. The labrum is furnished with sixteen setae, the arrangement and length of which serve as specific characters. Four pitlike structures occur on the dorsal face of the labrum. They have a definite position in some species, but may vary to a slight extent in others. These structures were called "sensory spots" by MacGillivray (1903). He also named the labral setae, and his terminology is used here, except for the addition of one term, namely, the "angular," as used by Böving (1910). Those setae which project from the anterior labral margin are called "marginal" setae; the one near the lateral margin, usually the longest, is the angular seta. In this paper the seta at the latero-anterior angle is designated as the angular, and the other setae in

succession medially are  $m^2$ ,  $m^3$ , and  $m^4$  (Pl V, Fig 59) Six "discal" setae project from the dorsal face of the labrum; two "proximal" setae are always closer to the caudal margin (Pl V, Fig 59, *ps*), two "distal" setae occur just caudad of the mid-anterior edge (Pl V, Fig 59, *ds*), there are two "medial" setae, each of which is laterad of the distal seta and mediad of the lateral seta (Pl V, Fig 59, *ms*) Two other setae, always near the lateral labral edges, are termed the "lateral" setae (Pl V, Fig 59, *ls*) In a very few specimens one pair of setae may be absent, or an additional pair may be present, which may be the reason why MacGillivray (1903) described two pairs of marginal setae in *Haemonia nigricornis*, although his figure shows three In a few of the older larvae marginal setae may be worn or broken, a circumstance which causes difficulty in judging the length of the pairs In all species except *D. flavipes* definite lateral wings, which may either project beyond the lateral surface or appear to be a continuation of it, are present at the caudal end of the lateral edge

#### LACINIAE (Pl VI, Figs 69-79)

The lacinia is the only part of the maxilla that can be easily used for taxonomic purposes The maxillae in the American *Donacini* do not differ generally from those of the species discussed by Böving (1910) The lacinia is an ear-shaped projection from the anterior portion of the heavily sclerotized band of the stipes and is dorso-mediad of the palpus The dorsal side is in the form of a niche (Pl VI, Fig 71, *nc*), which opens toward the mouth On the medial side of the niche is a heavily sclerotized bow-shaped band (Pl VI, Fig 71, *bs*) This band bears two keel-shaped chitinous folds on its niche side and continues laterad as a thin sclerotized basin The caudal part of the bow-shaped portion connects with the distal medial sclerotized band of the stipes On the dorsolateral side of the niche there is a strongly sclerotized process, the chitinous process of Böving (1910), which is jagged at the posterior end and serves as a muscle attachment (Pl VI, Fig 71, *cp*) On the anterior end of the outer face of the chitinous process can be found two rows of hairlike projections (Pl VI, Fig 71, *hp*), the "emergence-clad portion" (Böving, 1910) These hairlike processes extend over the niche and obliquely cephalad They do not occur in *Donacia flavipes* At the anterior end of the bow-shaped band there is a needle-like structure (Pl VI, Fig 71, *ns*) united to the band by a joint. Ventral to the needle-

shaped structure is a soft scalpel-like blade which Böving (1910) suggests might be termed the "galea." Projecting into the niche and continuing along the side of the needle-shaped portion is a boot-shaped structure which is bifurcate, forming two setae. Böving (1910) discovered that the length of the needle-shaped portion compared to other parts of the lacinia is a good character for classification.

#### CHITINOUS BOWS OF LABIA (Pl. III, Figs 36-46)

The chitinous bow is the only highly sclerotized region of the labium and is the one part showing enough variation to be used as a character for classification. In this paper the term "chitinous bow of labium" will be used as it is by Böving (1910). The chitinous bow is either semicircular or V-shaped.

#### CAUDAL SPINES (Pl. VI, Figs 80-90)

The caudal spine consists of a base and a hook-shaped terminus. It is attached to the dorsum of the eighth abdominal segment. The base encloses a soft-walled oval space containing the spiracle, which is a slit elongated in an anteroposterior direction. The hook-shaped portion varies in length and curvature in the different species. The relation of the length of the hook to the soft-walled oval space makes an excellent character for separating *Donacia cineticornis*, *D. proxima*, and *D. piscatrix* from all other species. *D. proxima* and *D. palmata* (the latter described by MacGillivray, 1903) have serrations at the tip of the hook-shaped portion.

#### BODY SETAE (Pls. VII-X, Figs 91-101)

The bodies of *Donacium* larvae are covered with setae which vary in number and pattern in the species studied. For the purposes of this paper the terminology of the different groups of setae as used by MacGillivray (1903) has been adopted. He calls the groups of setae on the dorsum of each segment "tergal", the anterior transverse row "anterior tergal" (Pl. VII, Fig. 91, *at*); the posterior row "posterior tergal" (Pl. VII, Fig. 91, *pr*); those above the spiracles and ventrad of the tergal groups "supraspiracular" (Pl. VII, Fig. 91, *ss*), and those below the spiracles "infraspiracular" (Pl. VII, Fig. 91, *is*); the "pedal" setae (Pl. VII, Fig. 91, *pds*) are those which surround the legs in the thorax and those found in a similar position in the abdomen; the "sternal" setae are those on the ventral side, which in the thoracic segments can be divided into "anterior"

(Pl. VII, Fig. 91, *ast*) and "posterior sternal" setae (Pl. VII, Fig. 91, *pst*), and in the abdominal segments can be divided along the mid-ventral line (Pl. VII, Fig. 91, *st*), but never transversely.

#### DESCRIPTIONS

##### *Haemonia nigricornis* Kirby

Egg (Pl. I, Fig. 1)

Egg mass

*Size*. — Length of egg and gelatinous envelope, 1.20–1.46 mm, average of 30 masses, 1.35 mm; width, 0.51–0.69 mm, average of 30 masses, 0.57 mm

*Shape*. — Egg with gelatinous envelope elongate, gelatinous coat thick on sides of egg, often only on middle of top of egg. Gelatin-covered eggs, in groups, arranged in one row on inner sides of stipules of *Potamogeton natans*, long axes of envelopes parallel with or oblique to edge of stipule, envelopes usually in contact with one another.

*Color*. — Gelatinous envelopes distinctly yellow, ends of egg colorless when not covered by gelatinous substance.

*Location*. — Deposited on inner sides of submerged stipules of *Potamogeton natans*.

Egg

*Size*. — Length, 1.02–1.17 mm; average of 30 eggs, 1.14 mm; width, 0.36–0.47 mm, average of 30 eggs, 0.42 mm. Length and width increasing during development.

*Shape*. — Elongate, both ends bluntly pointed, chorion thin, apparently smooth, micropyle not visible.

*Color*. — Yellow throughout development, colored yolk concentrated near middle of egg, ends clear, two rows of black ocelli appearing before hatching, three in front row and two in back.

*Period of development*. — Sixteen days.

#### LARVAE

General features (Pl. II, Fig. 13)

Eruciform; 8–11 mm. long at time of formation of cocoon; decreasing greatly in diameter anteriorly from second abdominal segment; abdominal segment 7 not greatly reduced in diameter, dorsal half of tergum broadly pointed, remaining portion of tergum flattened ventrally; abdominal segments 8, 9, and 10 short, capable of extend-

ing beyond apices of caudal spines; caudal spines projecting cephalad. Legs large. Green.

### Ocelli

Five; two rows, three in front row and two in back; black.

### Mandible (Pl. III, Fig. 24)

Flat, triangular, about as long as width of base. Two apical teeth, pointed, curving strongly toward cutting edge. Lateral surface curved, upper half convex and continuous with outer tooth, remaining surface to condyle approximately straight or weakly convex, beak portion serving as extensor muscle attachment, curving laterad and caudad, and often with a middle depression. Cutting edge curved, region just proximad of inner tooth a moderate to deep concavity, with large denticles lining concavity and base of inner tooth, middle third usually concave but sometimes straight, proximal third convex and ending in distinct hook. Border of basal end between condyle and cutting surface straight or curved, when curved having a middle convex portion and medial and lateral concavities.

### Frons (Pl. IV, Fig. 47)

Pentagonal, distance between lateral angles approximating distance between occipital angle and mid-anterior point, posterolateral edge usually slightly shorter than distance between lateral angles, and approximately straight to occipital region; occipital point sharp but not elongated and narrow, anterior angles usually closer to 100° than to 120°, tip of angle often sharp; heavily sclerotized antero-lateral band curving strongly and evenly laterad. Eight long thin setae. Two pitlike structures.

### Labrum (Pl. V, Fig. 58)

Five-sided; slightly less than twice as wide as long; pointed posterolateral wings projecting definitely laterad in posterior portion; remaining part of lateral sides oblique or curving to unite with anterior margin at bases of angular setae; anterior margin emarginate, generally with a long median concavity, small lateral concavities occurring at bases of angular setae, lateral concavities often appearing as part of lateral rather than of anterior border. Eight marginal setae; angular longest; angular, second, and third subequal in size; fourth usually as long as third; second marginal closer to angular than to third marginal; third and fourth pairs grouped,

usually equidistant and equal in length, sometimes distance between setae of fourth pair slightly greater than that between third and fourth pairs. Six discal setae, proximal longest, median setae lateral and posterior to distal, usually longer than angular; distal setae capable of extending to apices of third and fourth marginal setae. Two lateral setae, usually lateral to proximal and sometimes slightly anterior to them. Four pitlike structures, one pair posterior and often slightly lateral to distal setae, the other pair posterior and slightly lateral to proximal setae. All setae long and tapering evenly to a point. Heavily sclerotized band usually extending from bases of third and fourth marginal setae to a point between bases of proximal setae.

#### Lacina (Pl. VI, Fig. 69)

Short, needle-shaped portion from one fifth to one third shorter than bow-shaped portion and slightly shorter to about one third shorter than region bearing hairlike projections, chitinous process more than twice as long as needle-shaped portion, occasionally three times as long.

#### Chitinous bow of labium (Pl. III, Fig. 36)

Semicircular, inner, posterior surface usually irregular.

#### Caudal spine (Pl. VI, Fig. 80)

Short, a line from posteroventral end of basal part to apex of hook one fifth to one third longer than basal part, hook-shaped portion five to six times as long as soft-walled oval space enclosing spiracle. Weakly curved, tapering evenly to blunt point.

#### Body setae (Pl. VII, Fig. 91)

Anterior tergal setae sparse, two to three rows of widely separated setae in central region of first six abdominal segments, sometimes four rows in segments 5 and 6, one to two rows in mesothorax and metathorax; three groups in mesothorax, metathorax, and first six abdominal segments, central groups separate or connected with lateral groups by one row; few setae in seventh, usually less than fifteen, often between five and twelve. Posterior tergal setae few and widely separated, one to three rows in mesothorax, metathorax, and first six abdominal segments; seventh segment with definite band of widely separated setae, larger number in central region. Supraspiracular

separated into two small groups in mesothorax and metathorax, sparse in all abdominal segments and usually forming a continuous group in first five segments, sometimes separated into two groups in sixth, not extending caudad of anterior row of posterior tergal band in first five abdominal segments, separated from or connected with anterior tergal band in first six abdominal segments by one row, not connected with anterior tergal in seventh, sparse in seventh, usually less than six, often between one and four, not connected with posterior tergal band. Infraspiracular not numerous, separated into two groups or composing one continuous group in mesothorax and metathorax, united with posterior tergal and pedal setae in seventh abdominal. Pedal setae not numerous. Anterior sternal of mesothorax and metathorax usually sparse, generally not in definite row, not coalesced with posterior sternal. Posterior sternal sparse, two groups in mesothorax and metathorax. Abdominal sternal few, narrowed in central portion of all segments, often separated into two groups in segments 3 through 7. All tergal setae long but not stout, those of sixth and seventh exceptionally long, sternal setae small, often not easily seen.

*Donacia piscatrix* Lacordaire

Egg (Pl I, Fig 2)

Egg mass

*Shape* — Eggs with gelatinous envelopes forming irregular mass, individual gelatinous envelopes distinct from one another, secondary grooves on each gelatinous envelope

*Color* — Gelatinous envelopes yellow, opaque, eggs not visible through envelopes

*Location* — Deposited on submerged part of peduncle of *Nymphaea advena*

Egg

*Size* — Length, 0.73–0.87 mm.; average of 30 eggs, 0.82 mm; width, 0.32–0.36 mm; average of 30 eggs, 0.34 mm. Length and width increasing with development

*Shape* — Elongate; one end bluntly rounded and other bluntly pointed, chorion thin, apparently smooth; micropyle not visible.

*Color* — Light cream to white when first laid; yolk filling entire egg, before hatching changing to light yellow, two rows of brown



to black ocelli appearing before hatching, three in front row and one or two, usually one, in back.

*Period of development* — Sixteen days.

#### LARVAE

General features (Pl II, Fig 14)

Eruciform, 12-16 mm. long at time of formation of cocoon, gradually decreasing in diameter anteriorly and posteriorly from middle of body; abdominal segments 8, 9, and 10 long and tapering, when fully extended capable of protruding beyond apices of caudal spines; caudal spines projecting ventrad or caudad. Legs of moderate size. White.

#### Ocelli

Four or five, two rows, three in front row and one or two, usually one, in back; black

Mandible (Pl III, Fig. 25)

Flat, triangular, about as long as width of base. Two apical teeth, bluntly pointed, curving strongly toward cutting edge. Lateral surface curved, upper third convex and continuous with outer tooth, remaining surface to condyle varying with curved and straight parts; beak portion serving as extensor muscle attachment, curving laterad and caudad. Cutting edge curved, region just proximad of inner tooth a long deep concavity with large denticles lining concavity and basal half of inner tooth, region proximad of serrate concavity varying from straight to convex but usually convex in basal third. Border of basal end between condyle and cutting surface curved, cutting half concave, condyle half convex.

Frons (Pl. IV, Fig 48)

Pentagonal, distance between lateral angles usually slightly shorter than distance between occipital angle and mid-anterior point, sometimes distinctly shorter; posterolateral edge generally approximating distance between lateral angles, sometimes slightly longer, and usually concave to occipital region; occipital point elongated and narrow; anterior angles variable in width; heavily sclerotized antero-lateral band usually bending strongly laterad. Eight long setae. Two pitlike structures.

**Labrum (Pl. V, Fig. 59)**

Five-sided, from about one and one-half to two times as wide as long; short posterolateral wings projecting slightly laterad; remaining part of lateral sides curving to unite with anterior margin below proximal ends of angular setae, often evenly curved; anterior margin with middle shallow depression varying in length, sometimes with slight indentation at base of angular seta. Eight marginal setae, angular longest, angular, second and third subequal in size, fourth sometimes as long as third; second marginal closer to angular than to third marginal; distance between fourth marginal setae greater than that between third and fourth pairs. Six discal setae, proximal longest; median setae lateral and slightly posterior to distal; distal setae short, usually not capable of extending to apices of third marginal, generally projecting upright. Two lateral setae, lateral and in line with or slightly anterior to proximal. Four definite pitlike structures; one pair usually between and in line with medial and distal setae, generally closer to distal than to medial; the other pair often lateral and slightly posterior to proximal setae, one additional pair sometimes between bases of second and third marginal setae, but when present not clearly visible. All setae tapering gradually from base to point, third and fourth pairs needle-like. Heavily sclerotized band extending from mid-posterior edge to insertion of fourth marginal setae.

**Lacinia (Pl. VI, Fig. 70)**

Elongate, needle-shaped portion approximately one fourth longer than bow-shaped portion and usually more than one third longer than region bearing hairlike projections; chitinous process one fifth to one fourth longer than needle-shaped portion.

**Chitinous bow of labium (Pl. III, Fig. 37)**

Semicircular; usually one elongated low posterior projection and two lateral swellings.

**Caudal spine (Pl. VI, Fig. 81)**

Elongate; a line from posteroventral end of basal part to apex of hook about three times as long as length of basal part, usually slightly shorter; hook-shaped portion nine to ten times as long as soft-walled oval space enclosing spiracle. Strongly curved, tapering evenly to pointed tip.

## Body setae (Pl VII, Fig 92)

Anterior tergal setae moderate in number, about three to six rows in first six abdominal segments, about two to four rows in mesothoracic and metathoracic segments; three definite groups in mesothoracic, metathoracic, and first six abdominal segments, central groups separate or connected with lateral groups by one row of setae in first six abdominal segments, usually separated in mesothorax and metathorax, a few widely separated or centrally massed setae in seventh abdominal segment, usually fewer than twenty, often between ten and eighteen. Posterior tergal setae moderate in number, about three to five rows in mesothorax, metathorax, and first seven abdominal segments, sometimes fewer in mesothorax, metathorax, and seventh abdominal segment, only one to three rows in lateral extremities in first six abdominal segments, not connected with anterior tergal band in mesothorax and metathorax, sometimes continuing cephalad with one row in seventh abdominal segment. Supraspiracular groups separated in mesothorax and metathorax; elongate and not divided in first six abdominal segments, usually not extending posterior beyond anterior row of lateral extremities of posterior tergal band in abdominal segments, first six abdominal groups usually not coalescing with anterior tergal band, occasionally some segments coalesced by one row of setae, seventh generally not coalesced with anterior tergal group, number reduced in seventh abdominal segment, usually fewer than five setae, often one to four. Infraspiracular of mesothorax and metathorax generally not divided into two groups, when divided, posterior group containing but a few, number often gradually reducing in fifth, sixth, and seventh abdominal segments. Usually slightly fewer pedal setae in fifth, sixth, and seventh abdominal segments. Anterior sternal group of mesothorax broken or continuous and not coalesced with posterior sternal group, coalesced or weakly separated in the metathorax and separate or united to posterior sternal by one or two rows of setae. Posterior sternal in two separated groups or united at anterior ends in mesothorax; usually united in anterior portion in metathorax. Sternal group narrowed or separated in fourth abdominal segment, separated into two groups in fifth, sixth, and seventh abdominal segments, in a few instances narrowed in fifth.

*Donacia proxima* Kirby

Egg (Pl I, Fig 3)

Egg mass

*Shape* — Eggs with gelatinous envelopes arranged in double row around hole in leaf, outer and attached surfaces flat; gelatinous envelopes arranged in two distinct rows, secondary grooves on each envelope

*Color* — Gelatinous envelopes white, opaque, eggs not visible

*Location* — Deposited on under side of leaf of *Nymphaea advena*

Egg

*Size* — Length, 0.91–0.98 mm ; average of 30 eggs, 0.97 mm , width, 0.36–0.40 mm ; average of 30 eggs, 0.37 mm Length and width increasing with development

*Shape* — Elongate, ends bluntly rounded, chorion thin, apparently smooth, micropyle not visible

*Color* — Pale yellow when first laid; yolk filling almost entire egg, before hatching changes to distinct yellow, two rows of brown to black ocelli appearing before hatching, three in front row and two in back

*Period of development* — Sixteen days

## LARVAE

General features (Pl. II, Fig 15)

Eruciform; 12–16 mm. long at time of formation of cocoon; gradually decreasing in diameter anteriorly and posteriorly from middle of body; abdominal segments 8, 9, and 10 long and tapering, when fully extended capable of protruding beyond apices of caudal spines; caudal spines projecting ventrad or caudad. Legs of moderate size. White

Ocelli

Five; two rows, three in front row and two in back; black.

Mandible (Pl. III, Fig. 26)

Flat, triangular, slightly longer than width of base. Two apical teeth, bluntly pointed, curving strongly toward cutting edge. Lateral surface curved, upper half usually convex and continuous with outer tooth, remaining surface to condyle varying with curved and straight portions; beak part serving as extensor muscle attachment, curving

laterad and caudad. Cutting edge curved, region just proximad of inner tooth a long deep concavity either smooth or with large denticles, region proximad of concavity usually composed of two convex regions. Border of basal end between condyle and cutting surface curved, cutting third concave, condyle two thirds straight to convex.

**Frons (Pl. IV, Fig. 49)**

Pentagonal, distance between lateral angles usually slightly shorter than distance between occipital angle and mid-anterior point, sometimes distinctly longer, posterolateral edge generally approximating distance between lateral angles, sometimes distinctly shorter, and usually concave to occipital region, sometimes straight, occipital point generally elongated and narrow, occasionally only slightly narrowed, anterior angles variable in width; heavily sclerotized anterolateral band usually bending strongly laterad. Eight long setae. Two pitlike structures.

**Labrum (Pl. V, Fig. 60)**

Five-sided; from about one and one-half to two times as wide as long; posterolateral wings generally broadly rounded and projecting laterad; remaining part of lateral sides curving to unite with anterior margin below proximal ends of angular setae, strongest curve usually just lateral to base of angular seta; anterior margin with middle, moderately deep depression of variable length, sometimes with slight indentation at base of angular seta. Eight marginal setae; angular longest; angular and second subequal in size; third sometimes as long as second; fourth sometimes as long as third; second marginal closer to angular than to third marginal; distance between setae of fourth marginal pair greater than that between third and fourth pairs. Six discal setae; proximal longest; median setae varying from directly lateral to lateral and slightly anterior or posterior to distal setae; distal setae long, usually capable of extending beyond the apices of the third marginal, projecting in an anterior direction. Two lateral setae, lateral and in line with or slightly anterior to proximal. Usually six pitlike structures; one pair varying from posterior to lateral to distal setae (sometimes one additional pair in this region); one pair posterior and slightly lateral to proximal setae; one pair ordinarily between bases of second and third marginal setae. Third and fourth marginal setae usually stout, blunt to pointed, generally tapering strongly only in distal half, sometimes reduced

to stubs because of breakage or wear. Heavily sclerotised band extending from mid-posterior edge to insertion of fourth marginal setae.

**Lacinia (Pl VI, Fig. 71)**

Elongate; needle-shaped portion one fourth to one third longer than bow-shaped portion and usually more than one third longer than region bearing hairlike projections; chitinous process one fourth to one third longer than needle-shaped structure

**Chitinous bow of labium (Pl III, Fig. 38)**

Semicircular; usually one posterior bluntly pointed projection of moderate size.

**Caudal spine (Pl VI, Fig. 82)**

Elongate; a line from posteroventral end of basal part to apex of hook about three times as long as length of basal part, hook-shaped portion ten to twelve times as long as soft-walled oval space enclosing spiracle. Moderately curved, tapering evenly, tip serrate on inner edge.

**Body setae (Pl VII, Fig. 93)**

Anterior tergal setae numerous, about five to seven rows in metathorax and first six abdominal segments, sometimes slightly fewer in metathorax, two to four rows in mesothorax; three definite groups in mesothorax, metathorax, and first six abdominal segments, central groups connected with lateral groups by one or two rows of setae in first six abdominal segments, separated or connected in mesothorax and metathorax; usually less than twenty widely separated setae in seventh abdominal segment, often between ten and fifteen. Posterior tergal setae numerous, about five to seven rows in mesothorax, metathorax, and first seven abdominal segments, sometimes fewer in mesothorax, metathorax, and seventh abdominal segment, only two or three rows in lateral extremities; usually not connected with anterior tergal in mesothorax and metathorax but sometimes connected by one row. Supraspiracular groups separated in mesothorax and metathorax; not divided in first six abdominal segments; usually not extending posterior to anterior row of lateral extremities of posterior tergal band; first six abdominal groups usually coalescing with anterior tergal band, sometimes weakly separated in third, fourth, fifth, and sixth segments; seventh usually not coalesced with

anterior or posterior tergal band, fewer setae in seventh abdominal, usually less than six. Infraspicular of mesothorax and metathorax usually divided into two groups, fused or separated, number often gradually decreasing in fifth, sixth, and seventh abdominal segments. Generally fewer pedal setae in seventh abdominal segment. Anterior sternal usually continuous in mesothorax and not coalesced with posterior sternal group, separated or coalesced in metathorax and usually united with posterior sternal by one or two rows of setae. Posterior sternal generally in two separated groups in mesothorax, usually united in anterior portion of metathorax. Sternal of fourth abdominal segment sometimes narrowed, those of fifth generally separated into groups, sometimes only narrowed in mid-ventral line, those of sixth and seventh separated into groups.

*Donacia cinchicornis* Newman

Egg (Pl I, Fig 4)

Egg mass

*Size* — Width of double row of eggs, 2.50–3.33 mm; average of 30 masses, 3.15 mm; length varying with number of eggs.

*Shape* — Eggs in gelatinous matrix arranged in double row around hole in leaf, outer surface of matrix convex, attached surface flat; no apparent demarcation between individual gelatinous envelopes in each row but individual envelopes can be separated by dissection.

*Color* — Gelatinous matrix translucent, with two rows of cream-colored eggs showing through.

*Location* — Deposited on under side of leaf of *Castalia odorata*.

Egg

*Size* — Length, 0.84–0.95 mm; average of 30 eggs, 0.90 mm; width, 0.32–0.40 mm; average of 30 eggs, 0.36 mm. Length and width increasing with development.

*Shape* — Elongate, ends bluntly rounded, curving more strongly on one side than on other; chorion thin, apparently smooth, micropyle not visible.

*Color* — Cream when first laid, ends clear; changing to yellow before hatching, two rows of brown to black ocelli appearing before hatching, three in front row and two in back.

*Period of development* — From 12 to 13 days.

**LARVAE****General features (Pl II, Fig 16)**

Eruciform, 11-15 mm long at time of formation of cocoon, gradually decreasing in diameter anteriorly and posteriorly from middle of body, abdominal segments 8, 9, and 10 long and tapering, when fully extended capable of protruding beyond apices of caudal spines, caudal spines projecting ventrad or caudad. Legs of moderate size. White.

**Ocelli**

Five; two rows, three in front row and two in back, black.

**Mandible (Pl III, Fig 27)**

Flat, triangular, about as long as width of base. Two apical teeth, usually rounded but sometimes bluntly pointed, curving strongly toward cutting edge. Lateral surface curved, upper third convex and continuous with outer tooth, remaining part of surface to condyle varying with curved and straight portions, beak portion serving as extensor muscle attachment, curving laterad and caudad. Cutting edge curved, region just proximad of inner tooth a long deep concavity either entirely smooth or with distinct elongated denticles, region proximad of concavity varying from straight to convex but usually convex in basal third. Border of basal end between condyle and cutting surface varying from unevenly straight to curved, when curved cutting half concave and condyle half slightly convex.

**Frons (Pl IV, Fig 50)**

Pentagonal, distance between lateral angles distinctly longer than distance between occipital angle and mid-anterior point, often one fifth longer; posterolateral edge distinctly shorter than distance between lateral angles and usually approximately straight to occipital region; occipital point sharp but not elongated and narrow, anterior angles variable in width, tip of angle often sharp; heavily sclerotized anterolateral band usually curving moderately and evenly laterad. Eight long setae. Two pitlike structures.

**Labrum (Pl V, Fig 61)**

Five-sided; from about one and one-half to two times as wide as long, posterolateral wings usually not projecting laterad, often lobed; remaining part of lateral sides usually straight and frequently lobed, sometimes curved; anterior margin emarginate, with a mod-



erate to deep middle depression, two lateral indentations at bases of angular and second marginal setae. Eight marginal setae; angular longest; angular, second, and third subequal, fourth sometimes as long as third; second marginal closer to angular than to third; distance between setae of fourth marginal pair greater than that between third and fourth pairs. Six discal setae; proximal longest, median setae varying from directly lateral to lateral and slightly anterior or posterior to distal setae; distal setae long, usually capable of extending to or beyond apices of fourth marginal, projecting in an anterior direction. Two lateral setae; lateral and in line with or slightly anterior to proximal. Usually six pitlike structures, one pair lateral to distal and usually in line with medial; one pair posterior and lateral to proximal, one pair usually between bases of second and third marginal setae. Marginal setae stout, angular and second often tapering only in distal two thirds, third and fourth blunt to pointed and generally tapering only in distal half, third and fourth sometimes reduced to stubs because of breakage or wear. Heavily sclerotized band extending from mid-posterior edge to insertion of fourth marginal setae.

#### Lacinia (Pl. VI, Fig. 72)

Elongate; needle-shaped portion approximately one fourth longer than bow-shaped portion and about one third longer than region bearing hairlike projections, chitinous process about one fifth to one fourth longer than needle-shaped structure

#### Chitinous bow of labium (Pl. III, Fig. 39)

Semicircular, usually one small posterior pointed projection

#### Caudal spine (Pl. VI, Fig. 83)

Elongate; a line from posteroventral end of basal part to apex of hook three or more times as long as length of basal part; hook-shaped portion nine to eleven times as long as soft-walled oval space enclosing spiracle. Weakly curved, tapering evenly to wedge-shaped point

#### Body setae (Pl. VIII, Fig. 94)

Anterior tergal setae numerous, about five to seven rows in metathorax and first six abdominal segments, two to four rows in mesothorax; three definite groups in mesothorax, metathorax, and first six abdominal segments, central groups connected with lateral

groups by one or two rows of setae in first six abdominal segments, separated or connected in mesothorax and metathorax but usually separated in mesothorax, more than twenty setae in seventh abdominal segment, one definite band with an increased number in mid-dorsal area. Posterior tergal setae numerous, about four to seven rows in mesothorax, metathorax, and first seven abdominal segments, only two or three rows in lateral extremities; usually not connected with anterior tergal in mesothorax and metathorax, sometimes connected by one row. Supraspiracular groups divided in mesothorax and metathorax, not divided in first six abdominal segments; generally not extending posterior to anterior row of lateral extremities of posterior tergal band; first six abdominal groups usually coalescing with anterior tergal band, sometimes weakly separated in third, fourth, fifth, and sixth segments; seventh usually not coalesced with anterior tergal group, sometimes connected, seventh sometimes connected with posterior tergal band by one row of setae, fewer setae in seventh abdominal segment, generally less than ten. Infraspicular of mesothorax and metathorax usually not separated into two groups, if separated posterior group composed of few setae; number often gradually decreasing in fifth, sixth, and seventh abdominal segments. Usually fewer pedal setae in seventh abdominal segment. Anterior sternal generally continuous in mesothorax and not coalesced with posterior sternal group, separated or coalesced in metathorax and usually united with posterior sternal by one or two rows of setae. Posterior sternal generally in two separated groups in mesothorax; usually united in anterior portion of metathorax. Sternal of fifth abdominal usually narrowed in mid-ventral line, sometimes separated into two groups, always separated into two groups in sixth and seventh abdominal segments.

*Donacia hirticollis* Kirby

Egg (Pl. I, Fig. 7)

Egg mass

*Size.* — Length of egg and gelatinous envelope, 1.06–1.39 mm., average of 30 masses, 1.20 mm.; width, 0.47–0.58 mm., average of 30 masses, 0.51 mm.

*Shape.* — Egg with gelatinous envelope elongate; one end of envelope rounded, one end often with short gelatinous tail; upper and lower gelatinous surfaces attached between submerged leaves

or submerged plant stem and its stipules. Gelatin-covered eggs, in groups, deposited in an irregular mass; long axes of envelopes usually leaning at an angle to edge of leaf or stipule but tending to be parallel with it.

**Color** — Gelatinous envelopes translucent to opaque, white; coat over top of egg usually thick enough to give white appearance to whole mass when viewed with naked eye.

**Location** — Collected from between stem and stipules of *Potamogeton natans* and between submerged parts of two *Sparganium angustifolium* leaves.

### Egg

**Size** — Length, 0.91–1.09 mm, average of 30 eggs, 0.99 mm; width, 0.36–0.43 mm, average of 30 eggs, 0.40 mm. Width increasing with development.

**Shape** — Elongate, one end bluntly rounded, other end bluntly pointed, chorion thin, apparently smooth, micropyle not visible.

**Color** — Cream throughout development; colored yolk concentrated near middle, two rows of black ocelli appearing before hatching, three in front row and two in back.

**Period of development** — Twelve days.

### LARVAE

General features (Pl. II, Fig. 17)

Eruciform, 12–14 mm long at time of formation of cocoon, gradually decreasing in diameter anteriorly and posteriorly from middle of body, abdominal segments 8, 9, and 10 short, capable of protruding beyond apices of caudal spines; caudal spines projecting ventrad. Legs of moderate size. Usually light gray.

### Ocelli

Five; two rows, three in front row and two in back, black.

### Mandible (Pl. III, Fig. 28)

Flat, triangular, longer than width of base. Two apical teeth, bluntly pointed, curving weakly toward cutting edge. Lateral surface curved in distal third and continuous with outer tooth, remaining surface nearly straight to base of condyle; beak portion serving as extensor muscle attachment, slanting obliquely laterad in proximal two thirds. Cutting edge curved, distal two thirds usually straight,

proximal third convex and ending in a distinct hook, region just proximad and including inner tooth having large denticles. Border of basal end between condyle and cutting border curved, with a middle convex portion, a median indentation, and a lateral concavity.

#### **Frons (Pl. IV, Fig. 51)**

Pentagonal, distance between lateral angles equal to or slightly longer than distance between occipital angle and mid-anterior point; posterolateral edge equal to or slightly shorter than distance between lateral angles and approximately straight, often with slight convex region in middle, occipital region round to bluntly pointed and not greatly narrowed, anterior angles closer to  $120^\circ$  than  $100^\circ$ , heavily sclerotized anterolateral band generally bending strongly laterad, straight to weakly curved. Eight long setae. Two pitlike structures.

#### **Labrum (Pl. V, Fig. 62)**

Weakly five-sided; from one and one-half to two times as wide as long, posterolateral wing continuous with remaining part of lateral surface, union of anterior and lateral margins not distinct, usually a shallow to deep depression in region of second, third, and fourth pairs of marginal setae. Eight marginal setae, angular longest, setae of second, third, and fourth pairs equal in size and equidistant, distance between setae of fourth pair usually slightly greater than that between third and fourth pairs, sometimes the same. Six discal setae, proximal longest, median lateral and varying from posterior to anterior to distal, grouped with angular and lateral; distal setae generally not capable of extending to anterior margin, usually projecting upright. Two lateral setae, lateral and slightly posterior to medial setae. Four pitlike structures, one pair between distal and proximal setae, the other pair posterior and lateral to proximal setae. All setae tapering gradually from base to point, second, third, and fourth sometimes stout and blunt but still tapering evenly. Heavily sclerotized band usually extending from bases of fourth marginal setae to a point slightly posterior to bases of distal setae.

#### **Lacinia (Pl. VI, Fig. 73)**

Short; needle-shaped portion one fourth to one third shorter than bow-shaped portion and slightly shorter than region bearing hairlike projections; chitinous process over twice as long as needle-shaped structure, occasionally three times as long.

**Chitinous bow of labium (Pl. III, Fig. 40)**

Semicircular; inner posterior and inner lateral surfaces usually irregular.

**Caudal spine (Pl. VI, Fig. 84)**

Short; a line from posteroventral end of basal part to apex of hook slightly longer to one fourth longer than length of basal part; hook-shaped portion three to four times as long as soft-walled oval space enclosing spiracle. Moderately curved, thick at base, narrowed to sharp point at apex.

**Body setae (Pl. VIII, Fig. 95)**

Anterior tergal setae numerous, about five to seven rows in mesothorax, metathorax, and first six abdominal segments; three groups in mesothorax, metathorax, and first six abdominal segments, central groups connected with lateral groups by one to two rows in mesothorax and metathorax, one to three rows in first six abdominal segments; setae sparse in seventh, usually less than twenty, often between eight and sixteen. Posterior tergal setae numerous and widely separated, about four to six rows in mesothorax, metathorax, and first seven abdominal segments; definitely coalesced with anterior tergal band and usually with supraspiracular group in mesothorax and metathorax, sometimes coalesced with anterior tergal by one row in metathorax. Supraspiracular divided and often separated into two groups in mesothorax and metathorax; numerous widely separated setae in first six abdominal segments, groups extending caudad to posterior row of posterior tergal band in first six abdominal segments; coalescing with posterior tergal band in sixth abdominal segment, sometimes coalescing in first five abdominal segments; widely coalesced with anterior tergal band in first six abdominal segments, not coalesced in seventh; setae sparse in seventh, usually less than eight, often between two and six; usually not coalescing with posterior tergal band in seventh. Infraspiracular usually not divided in mesothorax and metathorax; often fewer in seventh abdominal segment; sometimes fused with posterior tergal band in seventh. Fewer pedal setae in seventh abdominal segment, coalesced with some or all sternal groups in first six abdominal segments. Anterior sternal not numerous in mesothorax and metathorax, two to three rows in central region, sometimes a few setae caudad to third row; not coalesced with posterior sternal groups. Posterior sternal

of mesothorax and metathorax in two separated groups or united at anterior ends. Sternal of seventh abdominal segment separated into two groups or continuous. Usually all setae long and stout, sometimes only those of fifth and sixth abdominal segments.

*Donacia pubescens* Le Conte

Egg (Pl I, Fig 6)

Egg mass

*Size* — Length of egg and gelatinous envelope, 1.24–1.39 mm.; average of 30 masses, 1.29 mm, width, 0.43–0.58 mm; average of 30 masses, 0.51 mm.

*Shape*. — Egg with gelatinous envelope elongate, envelope usually not extended into long gelatinous tail; gelatinous coat very thin over top of egg and thin at sides. Gelatin-covered eggs, in groups, arranged in single row on inner sides of submerged outer culm sheaths, long axes of envelopes usually parallel to edge of sheath; envelopes generally end to end.

*Color* — Gelatinous envelopes translucent; white, coat over top of egg thin enough to give differentiation between egg and gelatinous sides of envelope when viewed with naked eye.

*Location* — Deposited on inner sides of outer culm sheaths of *Scirpus occidentalis*

Egg

*Size*. — Length, 0.98–1.13 mm; average of 30 eggs, 1.08 mm.; width, 0.36–0.43 mm, average of 30 eggs, 0.39 mm. Width increasing with development.

*Shape*. — Elongate; one end bluntly rounded, other end bluntly pointed; upper side of egg convex, under side straight; chorion thin, apparently smooth; micropyle not visible.

*Color* — Cream throughout development, ends clear; two rows of black ocelli appearing before hatching, two in front row and two in back.

*Period of development*. — From 11 to 12 days.

LARVAE

General features (Pl. II, Fig. 18)

Eruciform; short, 9–11 mm. long at time of formation of cocoon; gradually decreasing in diameter anteriorly and posteriorly from

middle of body, abdominal segments 8, 9, and 10 short, capable of extending beyond apices of caudal spines, caudal spines projecting ventrad or cephalad. Legs of moderate size. Usually cream-colored.

#### Ocelli

Four; two rows, two in front row and two in back, black.

#### Mandible (Pl. III, Fig. 29)

Flat, triangular, about as long as width of base. Two apical teeth, bluntly pointed, outer one curving strongly toward cutting edge, inner edge of inner tooth not curving greatly mediad of cutting border, sometimes inner tooth rounded at apex. Lateral surface curved, upper half convex and continuous with outer tooth, remaining surface to condyle varying with convex and concave portions, beak portion serving as extensor muscle attachment, curving laterad and caudad, usually with a middle notch. Cutting edge curved, distal half straight to slightly concave with low denticles or serrate ridge just proximad of inner tooth, proximal half usually convex. Border of basal end between condyle and cutting surface curved, having a middle convex portion with lateral and median concavities.

#### Frons (Pl. IV, Fig. 52)

Pentagonal, distance between lateral angles approximating distance between occipital angle and mid-anterior point, posterolateral edge usually slightly shorter than distance between lateral angles, sometimes as long, and approximately straight to occipital region; occipital region pointed and slightly narrowed, anterior angle closer to 100° than 120°, tip of angle often rounded; heavily sclerotized anterolateral band curving weakly laterad. Eight long stout setae. Two pitlike structures.

#### Labrum (Pl. V, Fig. 63)

Five-sided; from about one and one-half to two times as wide as long, posterolateral wings projecting laterad and continuing down to bases of medial setae, remaining part of lateral sides oblique or curving to unite with anterior border lateral to bases of angular setae; mid-posterior projection moderate in length; anterior margin emarginate, definite depression within second marginal setae, usually a slight depression at bases of angular setae. Eight marginal setae; angular longest; second generally slightly longer than third; fourth equal to or smaller than third, second closer to third than to angular;

third usually closer to fourth than to second, distance between setae of fourth pair generally greater than that between third and fourth pairs, sometimes the same. Six discal setae, proximal longest, medial approximately lateral to distal, distal capable of extending beyond apices of third and fourth marginal. Two lateral setae, lateral and usually slightly anterior to proximal. Four pitlike structures; one pair posterior and slightly lateral to distal setae, the other pair posterior and slightly lateral to proximal setae. All setae stout, tapering gradually to a point, second, third, and fourth marginal sometimes blunt but still tapering evenly. Heavily sclerotized band extending from point between proximal setae to insertion of fourth marginal setae.

#### **Lacinia (Pl. VI, Fig. 74)**

Short, needle-shaped portion usually about one third shorter than bow-shaped portion and generally slightly shorter than region bearing hairlike projections, chitinous process from one and one half to two times as long as needle-shaped structure.

#### **Chitinous bow of labium (Pl. III, Fig. 41)**

Semicircular, posterior part generally thick, usually without irregularities.

#### **Caudal spine (Pl. VI, Fig. 85)**

Short, a line from posteroventral end of basal part to apex of hook about one fourth to one third longer than length of basal part, hook-shaped portion four to five times as long as soft-walled oval space enclosing spiracle. Moderately thick, weakly curved, tapering evenly to point.

#### **Body setae (Pl. VIII, Fig. 96)**

Anterior tergal setae moderate in number, about three to five rows in first seven abdominal segments, about two, to four rows in mesothorax and metathorax, three definite groups in mesothorax, metathorax, and first six abdominal segments, central groups separate or connected with lateral groups by one row of setae, sometimes connected by two rows in sixth abdominal segment; a definite band of setae in seventh abdominal segment, usually more than thirty, often between thirty-five and fifty. Few posterior tergal setae, about two continuous rows and often an interrupted third row in meso-



thorax, metathorax, and first four abdominal segments, often three or four rows in fifth and sixth segments; seventh with a definite band having an increased number of setae in central region; usually not connected with anterior tergal band in mesothorax and metathorax, sometimes connected by one row. Supraspiracular separated in mesothorax and metathorax; usually divided into two groups in first six abdominal segments, separated or connected by one row of setae, sometimes connected by more than one row in a few segments; not projecting caudad of anterior row of posterior tergal band in first five abdominal segments, sometimes projecting beyond this row in sixth; coalescing with anterior tergal band in all segments; usually ten or more setae in seventh; coalescing with posterior tergal in seventh. Infraspicular separated or weakly joined in mesothorax and metathorax, number not greatly reduced in seventh abdominal. Number of pedal setae reduced or not reduced in seventh; often coalesced with abdominal sternal in some or all segments. Anterior sternal of mesothorax and metathorax composed of a continuous band of two or three rows of setae, coalesced with posterior sternal, joined definitely in central region of posterior sternal or over its entire width. Posterior sternal in two groups or one continuous group, when in two groups connected at anterior ends. Sternal of seventh abdominal divided; sixth not narrowed. Setae stout and often long.

*Donacia quadricollis* Say

Egg (Pl. I, Fig. 10)

Egg mass

*Size* — Length of egg and gelatinous envelope, 1.24–1.83 mm.; average of 30 masses, 1.49 mm.; width, 0.58–0.73 mm.; average of 30 masses, 0.64 mm.

*Shape* — Egg with gelatinous envelope elongate; envelope extended at one end as pointed gelatinous tail; gelatinous coat moderately thin over top of egg, thick at sides. Gelatin-covered eggs, in groups, arranged in single row on inner sides of submerged inner culm sheaths; long axes of envelopes leaning at an angle to edge of sheath and tending to be perpendicular to it.

*Color*. — Gelatinous envelope translucent; white; coat over top of egg thick enough to give white appearance to whole mass when viewed with naked eye.

*Location* — Deposited on inner sides of inner culm sheaths of *Scirpus occidentalis*

### Egg

*Size* — Length, 0.98–1.17 mm; average of 30 eggs, 1.09 mm.; width 0.43–0.54 mm.; average of 30 eggs, 0.48 mm. Length increasing, width decreasing with development.

*Shape*. — Elongate; one end bluntly rounded, other end bluntly pointed; upper side of egg convex, under side straight; chorion thin, apparently smooth, micropyle not visible

*Color*. — Cream throughout development; yolk filling entire egg; two rows of black ocelli appearing before hatching, three in front row and two in back.

*Period of development*. — From 12 to 13 days

### LARVAE

General features (Pl. II, Fig. 19)

Eruciform; of moderate size, 12–13 mm long at time of formation of cocoon; gradually decreasing in diameter anteriorly and posteriorly from middle of body, sixth abdominal segment not greatly reduced; abdominal segments 8, 9, and 10 short, capable of extending beyond apices of caudal spines; caudal spines projecting ventrad. Legs of moderate size. White

### Ocelli

Five; two rows, three in front row and two in back; black

### Mandible (Pl. III, Fig. 30)

Flat, triangular, about as long as width of base. Two apical teeth, outer one bluntly pointed or round and curving weakly toward cutting edge, inner one usually short and round but sometimes bluntly pointed, point of inner tooth usually not projecting beyond cutting surface. Lateral surface curved, upper half convex and continuous with outer tooth, remaining surface to base of condyle not distinct; beak portion serving as extensor muscle attachment, curving laterad and caudad. Cutting edge curved, region just proximal of inner tooth a long, shallow concavity with only a serrate ridge, proximal one third to one half usually strongly convex. Border of basal end between condyle and cutting surface curved, median portion convex with median and lateral concavities.

**Frons (Pl IV, Fig 53) -**

Pentagonal, distance between lateral angles usually distinctly longer than distance between occipital angle and mid-anterior point, posterolateral edge noticeably shorter than distance between lateral angles and usually irregularly convex, sometimes approximately straight, occipital region slightly narrowed and generally acutely rounded, anterior angles usually closer to  $120^\circ$  than  $100^\circ$ , tip of angle often rounded, heavily sclerotized anterolateral band projecting strongly laterad, curving moderately to weakly Eight long stout setae Two pitlike structures

**Labrum (Pl V, Fig 64)**

Five-sided, from one and one-half to two times as wide as long, posterolateral wings projecting slightly laterad, remaining part of lateral sides oblique or curved and uniting with anterior border just lateral to bases of angular setae, mid-posterior projection long, anterior margin emarginate, usually a definite depression in region of second, third, and fourth marginal setae, generally a slight depression at bases of angular setae Eight marginal setae, angular longest, second, third, and fourth of equal size and usually equidistant, sometimes distance between second and third slightly greater than that between third and fourth, distance between setae of fourth pair usually greater than that between third and fourth pairs, sometimes the same Six discal setae; proximal longest; median approximately lateral to distal setae, distal setae usually capable of extending beyond apices of fourth marginal setae, generally projecting in an anterior direction Two lateral setae, lateral and often anterior to proximal Four pitlike structures, one pair posterior and lateral to distal setae; the other pair posterior to proximal setae All setae stout, tapering gradually to a point, second, third, and fourth sometimes blunt but still tapering gradually Heavily sclerotized band extending from insertion of fourth marginal setae to a point between proximal pitlike structures

**Lacinia (Pl VI, Fig 75)**

Short; needle-shaped portion one fifth to one fourth shorter than bow-shaped portion and approximately as long as region bearing hairlike projections; chitinous process approximately twice as long as needle-shaped portion.

Chitinous bow of labium (Pl III, Fig 42)

Semicircular to weakly V-shaped, usually without irregularities

Caudal spine (Pl VI, Fig 86)

Short, a line from posteroventral end of basal part to apex of hook slightly longer to about one third longer than length of basal part, hook-shaped portion four to five times as long as soft-walled oval space enclosing spiracle. Weakly curved, tapering evenly to sharp point.

Body setae (Pl. IX, Fig 97)

Anterior tergal setae moderate in number, about three to five rows in first six abdominal segments, two to three rows in mesothorax and metathorax, sometimes four in metathorax, three definite groups in mesothorax, metathorax, and first six abdominal segments, central groups separate or connected with lateral groups by one row of setae, usually separated in mesothorax and metathorax, a definite band of setae in seventh abdominal, usually more than fifteen, often between twenty and thirty. Posterior tergal setae moderate in number, two to three rows of setae in mesothorax and metathorax, two to four rows forming a regular or irregular band in first six abdominal segments, seventh segment having a definite band with an increased number in central region, turning cephalad in lateral extremities; usually not connected with anterior tergal band in mesothorax and metathorax, sometimes connected by one row. Supraspiracular separated in mesothorax and metathorax, usually a continuous group in first four abdominal segments, often not narrowed in middle of first four, sometimes setae of one or two segments of the first four lobed, sometimes lobed or separated in two groups in fifth and sixth segments, often extending to anterior row of posterior tergal band in first five abdominal segments, frequently projecting to posterior row of posterior tergal band and sometimes fusing with latter in sixth segment; usually coalescing with anterior tergal band in first six abdominal segments, separated from anterior tergal band in seventh; setae sparse in seventh, usually less than ten, often between six and eight; seventh segment usually coalescing with posterior tergal band. Infraspicular divided into two groups in mesothorax and metathorax, separated or connected, generally slightly fewer in seventh segment. Usually fewer pedal setae in seventh abdominal segment; generally not connected with abdomi-

nal sternal. Anterior sternal of mesothorax and metathorax a continuous band or separated groups; few setae, not more than three rows, often one row; not coalesced with posterior sternal groups. Posterior sternal in two separated groups in mesothorax and metathorax, sometimes sparse. Sternal of seventh abdominal separated into two groups; usually narrowed or separated in sixth, sometimes not narrowed. Setae of moderate length.

*Donacia subtilis* Kunze

Egg (Pl. I, Fig. 8)

Egg mass

*Size*. — Length of egg and gelatinous envelope, 1.06–1.64 mm; average of 30 masses, 1.39 mm; width, 0.54–0.69 mm; average of 30 masses, 0.63 mm.

*Shape*. — Egg with gelatinous envelope elongate, ends of envelope rounded; gelatinous coat thick on sides of egg; upper and lower gelatinous surfaces attached to leaves. Gelatin-covered eggs, in groups, deposited in an irregular mass between two floating leaves.

*Color*. — Gelatinous envelope translucent; cream to light yellow; light-yellow egg visible within gelatinous border.

*Location*. — Deposited between two floating leaves. Collected on *Polygonum amphibium*, *Polygonum hydropiperoides*, *Nymphaea advena*, *Sparganium angustifolium*, and *Sparganium diversifolium*; collected on the latter only when leaves are broken so that they float.

Egg

*Size*. — Length, 0.98–1.17 mm; average of 30 eggs, 1.05 mm; width, 0.36–0.43 mm., average of 30 eggs, 0.41 mm. Length and width increasing with development.

*Shape*. — Elongate; one end bluntly rounded, other end bluntly pointed; upper side of egg convex, under side straight; chorion thin, apparently smooth; micropyle not visible.

*Color*. — Light yellow throughout development; yolk colored more in middle of egg than at ends; two rows of black ocelli appearing before hatching, three in front row and two in back.

*Period of development*. — Sixteen days.

LARVAE

General features (Pl. II, Fig. 20)

Eruciform; 12–16 mm. long at time of formation of cocoon; gradually decreasing in diameter anteriorly from middle of body,

fifth and sixth abdominal segments usually as large as fourth, diameter of seventh smaller; abdominal segments 8, 9, and 10 short, capable of extending beyond apices of caudal spines, caudal spines projecting ventrad. Legs of moderate size. Posterior segments often a distinct gray.

### Ocelli

Five; two rows, three in front row and two in back, black

### Mandible (Pl. III, Fig. 31)

Flat, triangular, about as long as width of base. Two apical teeth, outer tooth bluntly pointed and moderately curved, inner tooth curving strongly toward cutting edge. Lateral surface curved, upper half convex and continuous with outer tooth, remaining surface to condyle varying between convex and concave, beak portion serving as extensor muscle attachment, curving laterad and caudad, usually with a middle indentation. Cutting edge curved, region just proximad of inner tooth a long moderate concavity with numerous pointed denticles, region proximad of serrate concavity straight to convex but usually convex in basal third. Border of basal end between condyle and cutting surface curved, median portion convex with median and lateral concavities.

### Frons (Pl. IV, Fig. 54)

Pentagonal, distance between lateral angles usually distinctly longer than distance between occipital angle and mid-anterior point, posterolateral edge distinctly shorter than distance between lateral angles and usually slightly convex to occipital region; occipital region pointed or round, when pointed short and moderately narrowed; anterior angles closer to  $120^\circ$  than  $100^\circ$ ; heavily sclerotized anterolateral band generally bending strongly laterad, usually weakly curved. Eight long setae. Two pitlike structures.

### Labrum (Pl. V, Fig. 65)

Five-sided; from one and one-half to two times as wide as long; posterolateral wings projecting only slightly laterad or continuous with lateral border; remaining part of lateral sides straight-oblique or curved; mid-posterior projection short; anterior margin emarginate, with moderate to deep concavity limited to region between second marginal setae, lateral concavities in region of angular setae. Eight marginal setae; angular longest; second generally slightly

longer than third, fourth-sometimes as long as third; second closer to third than to angular, distance between setae of fourth pair greater than that between third and fourth pairs; distance between second and third greater than that between third and fourth. Six discal setae, proximal longest, median setae lateral and usually slightly posterior to distal, distal setae capable of extending from beyond anterior margin to tips of third marginal setae. Two lateral setae, lateral and usually slightly anterior to proximal. Four pitlike structures, one pair posterior and usually slightly lateral to distal setae; the other pair generally directly lateral to proximal setae. All setae thin and tapering to a fine point. Heavily sclerotized band extending from insertion of third and fourth marginal setae to point near bases of proximal setae.

#### Lacinia (Pl. VI, Fig. 76)

Short, needle-shaped portion one fourth to one third shorter than bow-shaped portion and approximately as long as region bearing hairlike projections; chitinous process about twice as long as needle-shaped structure.

#### Chitinous bow of labium (Pl. III, Fig. 43)

Semicircular, posterior part generally thick; without irregularities.

#### Caudal spine (Pl. VI, Fig. 87)

Short, a line from posteroventral end of basal part to apex of hook slightly longer to one third longer than length of basal part, hook-shaped portion four to six times as long as soft-walled oval space enclosing spiracle. Stout, weakly curved, tapering evenly to point.

#### Body setae (Pl. IX, Fig. 98)

Anterior tergal setae numerous, four to six rows in first six abdominal segments, two to five rows in mesothorax and metathorax, three definite groups in mesothorax, metathorax, and first six abdominal segments, separate or connected by one row of setae; few setae in seventh, usually less than twenty, often between six and sixteen. Number of posterior tergal setae moderate or large, about two to four rows in central region of mesothorax and metathorax, varying within band from two to five rows in first six abdominal seg-

ments but usually with four or five rows in central region, often continuing cephalad in seventh abdominal, separated or connected by one row with anterior tergal in mesothorax and metathorax. Supraspiracular separated into two groups in mesothorax and metathorax, elongate and not divided in first six abdominal segments, usually not extending caudad to anterior row of posterior tergal band in first five abdominal segments, those of sixth often extending beyond this point, first six abdominal segments generally coalescing with anterior tergal band, seventh separated from anterior tergal band, setae sparse in seventh, usually less than seven, often between one and five, seventh sometimes coalescing with posterior tergal band. Infraspiracular of mesothorax and metathorax usually separated into two groups, generally fewer in seventh segment. Fewer pedal setae in seventh abdominal. Anterior sternal of mesothorax and metathorax composed of one to three continuous rows of setae, distinctly separated from posterior sternal. Posterior sternal of mesothorax and metathorax usually in two groups. Sternal of seventh abdominal in two groups. All body setae generally short and thin.

*Donacia aequalis* Say

Egg (Pl I, Figs 9, 12)

Egg mass

*Shape* — Eggs lodged in gelatinous matrix, not in individual envelopes; irregular arrangement between two parts of one *Sagittaria* leaf, parts of leaf adhering to each other by gelatinous substance.

*Color* — Gelatinous matrix translucent, white; egg a distinct yellow.

*Location* — Deposited between tip of blade of one arrow-shaped leaf and surface of blade, tip turned back and attached to surface of blade by gelatinous substance. Collected on *Sagittaria latifolia*.

Egg

*Size* — Length, 0.69–0.76 mm; average of 30 eggs, 0.73 mm; width, 0.32–0.40 mm; average of 30 eggs, 0.35 mm. Length and width increasing with development.

*Shape* — Short; both ends usually broadly rounded, one side generally convex, other side usually straight; chorion thin, apparently smooth; micropyle not visible.



*Color* — Yellow throughout development, colored yolk concentrated near middle; two rows of brown ocelli appearing before hatching, three in front row and two in back

*Period of development* — Eight days

#### LARVAE

General features (Pl II, Fig 21)

Eruciform, short, 8–10 mm. long at time of formation of cocoon; gradually decreasing in diameter anteriorly and posteriorly from middle of body, abdominal segments 8, 9, and 10 short, capable of extending beyond apices of caudal spines; caudal spines projecting ventrad or cephalad. Legs of moderate size. Usually cream-colored.

#### Ocelli

Five, two rows, three in front row and two in back, black.

#### Mandible (Pl. III, Fig 32)

Flat, triangular, about as long as width of base. Two apical teeth, outer one bluntly pointed, inner one often rounded, both curving strongly toward cutting edge. Lateral surface curved, upper third strongly convex and continuous with outer tooth, remaining surface to base of condyle weakly convex, beak portion serving as extensor muscle attachment, curving laterad and caudad. Cutting edge curved, region just proximad of inner tooth a short concavity with large denticles, concavity as long as outer surface of inner tooth, usually convex in proximal half. Border of basal end between condyle and cutting surface curved, short indentation just lateral to cutting surface, remaining surface evenly convex.

#### Frons (Pl IV, Fig. 55)

Pentagonal; distance between lateral angles from slightly longer to distinctly longer than distance between occipital angle and mid-anterior point, posterolateral edge shorter than distance between lateral angles and usually approximately straight except for a shallow concavity posterior to lateral angle and a slight concavity in occipital region, occipital point not greatly narrowed and not elongated; anterior angles varying in width, tip of angle often evenly rounded; heavily sclerotized anterolateral band projecting strongly and conspicuously laterad, strong curve often occurring only near lateral angle. Eight long setae. Two pitlike structures.

**Labrum (Pl. V, Fig. 66)**

Five-sided; from one and one-half to two times as wide as long; posterolateral wings projecting only slightly laterad or continuous with lateral border; remaining portion of lateral surface varying from evenly curved to straight-oblique, anterior margin emarginate, with a long median concavity and two small lateral indentations confined to region of angular setae, the two lateral indentations appearing as part of lateral rather than anterior border. Eight marginal setae; angular usually slightly longer; inner setae usually equal, second marginal sometimes slightly longer; second, third, and fourth approximately equidistant, distance between second and third sometimes slightly greater than that between third and fourth, second closer to third than to angular, distance between setae of fourth pair usually slightly greater than that between third and fourth pairs. Six discal setae; proximal longest, median setae lateral and generally slightly posterior to distal; distal setae usually capable of extending to anterior margin, generally projecting upright. Two lateral setae, lateral and in line with or slightly anterior to proximal. Four pitlike structures, one pair posterior and very often slightly lateral to distal setae, the other pair varying from posterior to lateral to proximal setae. All setae tapering to a fine point. Heavily sclerotized band extending from mid-posterior point to all marginal setae.

**Lacinia (Pl. VI, Fig. 77)**

Short; needle-shaped portion approximating length of bow-shaped portion, and longer than region bearing hairlike projections; chitinous process about one third longer than bow-shaped and needle-shaped portions.

**Chitinous bow of labium (Pl. III, Fig. 44)**

V-shaped; posterior point a solid piece.

**Caudal spine (Pl. VI, Fig. 88)**

Short; a line from posteroventral end of basal part to apex of hook about as long as length of basal part; hook-shaped portion about four to five times as long as soft-walled oval space enclosing spiracle. Posterior surface strongly convex, tapering evenly to blunt point.

**Body setae (Pl IX, Fig 90)**

Anterior tergal setae few, two to four rows in first six abdominal segments, one to two rows in mesothorax and metathorax, three groups in mesothorax, metathorax, and first six abdominal segments, usually separated in mesothorax and metathorax and separate or connected by a single row in first six abdominal segments, a definite band of one to three rows of setae in seventh abdominal, usually more than twenty setae, often between twenty-two and thirty. Posterior tergal setae few, one or two rows of closely placed setae in a definite band in mesothorax, metathorax, and first four abdominal segments, one, two, or more rows in fifth and sixth abdominal, seventh having a definite band with an increased number of setae in central region, usually not connected with anterior tergal in mesothorax and metathorax. Supraspiracular separated into two groups in mesothorax and metathorax, usually separated into two groups in first six abdominal segments, sometimes two groups connected by one row; usually not extending caudad to anterior row of posterior tergal band in first six abdominal segments, sometimes extending caudad to anterior row in sixth abdominal; coalescing with anterior tergal band in first six abdominal segments, usually separated from anterior tergal in seventh but sometimes connected; setae sparse in seventh, usually less than ten; usually in two groups in seventh, posterior group coalescing with posterior tergal band. Infraspiracular separated into two groups in mesothorax and metathorax, often slightly fewer in seventh abdominal. Pedal setae often coalescing with some abdominal sternal groups; often fewer in seventh. Anterior sternal not numerous in mesothorax and metathorax, two or three rows in central region, sometimes a few setae caudad to third row; not coalesced with posterior sternal groups. Posterior sternal in two separated groups in mesothorax and metathorax, sometimes fused by one or two rows in middle. Sternal of seventh abdominal separated into two groups, those of sixth separated into two groups or continuous. Setae moderate to stout, length moderate in all segments.

*Donacia pubicollis* Suffrian**Egg (Pl I, Fig 5)****Egg mass**

*Size.* — Length of egg and gelatinous envelope, 1.46–1.83 mm., average of 30 masses, 1.67 mm.; width, 0.58–0.76 mm.; average of 30 masses, 0.68 mm.

**Shape** — Egg with gelatinous envelope elongate; envelope often extended at one end as pointed gelatinous tail, gelatinous coat thick over top and sides of egg. Gelatin-covered eggs, in groups, arranged in single row on inner sides of submerged culm leaves or on culms covered by leaves, long axes of envelopes parallel with or oblique to edge of leaf; envelopes separated or with ends in contact.

**Color** — Gelatinous envelopes translucent, white, coat over top of egg usually thick enough to give white appearance to whole mass when viewed with naked eye.

**Location** — Deposited on inner sides of submerged leaves or on culms underneath submerged leaves of *Phragmites communis*.

### Egg

**Size** — Length, 1.13–1.31 mm, average of 30 eggs, 1.28 mm; width, 0.47–0.54 mm, average of 30 eggs, 0.51 mm. No apparent change in size during development.

**Shape** — Elongate, one end bluntly rounded, other end bluntly pointed, chorion thin, apparently smooth, micropyle not visible.

**Color** — Cream throughout development, colored yolk concentrated near middle, usually two rows of black ocelli appearing before hatching, three in front row and two in back, number and arrangement sometimes varying in this species.

**Period of development** — From 12 to 13 days.

### LARVAE

#### General features (Pl. II, Fig. 22)

Eruciform, large, 13–16 mm long at time of formation of cocoon, gradually decreasing in diameter anteriorly from middle of body, seventh abdominal segment not greatly reduced; abdominal segments 8, 9, and 10 short, capable of extending beyond apices of caudal spines; caudal spines projecting ventrad. Legs of moderate size. Varying from cream-colored to white.

#### Ocelli

Generally five, two rows, usually three in front row and two in back, number and arrangement sometimes varying in this species, black.

#### Mandible (Pl. III, Fig. 33)

Flat, triangular, about as long as width of base. Two apical teeth, rounded, curving weakly toward cutting edge, inner tooth sometimes nearly absent. Lateral surface curved, upper half convex.

and continuous with outer tooth, remaining part to condyle varying with convex and concave portions, beak portion serving as extensor muscle attachment, curving laterad and caudad, usually with a middle indentation. Cutting edge curved, distal half a shallow depression with an irregular surface, proximal half usually convex. Border of basal end between condyle and cutting surface uneven, often with median convex portion and lateral and median concavities.

#### **Frons (Pl. IV, Fig. 56)**

Pentagonal; distance between lateral angles usually approximating distance between occipital angle and mid-anterior point, sometimes distinctly longer, posterolateral edge generally distinctly shorter than distance between lateral angles and usually concave in caudal one third to one half; occipital region pointed, not greatly narrowed; anterior angle generally closer to  $100^{\circ}$  than to  $120^{\circ}$ , tip of angle pointed or round; heavily sclerotized anterolateral band curving weakly to moderately laterad. Eight long stout setae. Two pitlike structures.

#### **Labrum (Pl. V, Fig. 67)**

Five-sided; from less than one and one-half to slightly more than one and one-half times as wide as long; posterolateral wings projecting laterad and continuing down to bases of medial setae; remaining part of lateral sides curving to unite with anterior margin just lateral to angular setae; anterior margin curved or straight. Eight marginal setae; angular longest; second usually slightly longer than third, sometimes only thicker; fourth generally as long as third, sometimes slightly smaller; second closer to third than to angular; distance between second and third usually greater than that between third and fourth; distance between setae of fourth pair generally not greater than that between third and fourth pairs. Six discal setae; proximal longest; median lateral and varying from anterior to posterior to distal, distal capable of extending to and often beyond apices of third and fourth marginal setae. Two lateral setae, lateral and generally anterior to proximal. Four pitlike structures; one pair posterior to distal; the other pair lateral and generally slightly posterior to proximal. All setae very stout and tapering evenly to a point, second, third, and fourth marginal sometimes blunt but still tapering evenly. Heavily sclerotized band usually extending from

mid-posterior edge to insertion of fourth marginal setae, sometimes not connected with mid-posterior edge.

**Lacinia (Pl. VI, Fig 78)**

Short, needle-shaped portion usually about one third shorter than bow-shaped portion and slightly shorter to about one fifth shorter than region bearing hairlike projections; chitinous process from two to three times as long as needle-shaped structure

**Chitinous bow of labium (Pl III, Fig 45)**

Semicircular, posterior portion slightly thicker; a posterior point sometimes present.

**Caudal spine (Pl VI, Fig 89)**

Short, a line from posteroventral end of basal part to apex of hook slightly longer to one fourth longer than length of basal part, hook-shaped portion four to five times as long as soft-walled oval space enclosing spiracle Stout, posterior edge strongly convex, tapering evenly to stout point

**Body setae (Pl. X, Fig 100)**

Anterior tergal setae moderate in number, about four to five rows of widely separated setae in central region of metathorax and first six abdominal segments, about three to four rows in mesothorax, three definite groups in mesothorax, metathorax, and first seven abdominal segments, central groups separate or connected with lateral groups by one row of setae in first seven abdominal segments; seventh composed of more than twenty-five setae Posterior tergal setae moderate in number, two definite rows forming a distinct straight band in mesothorax, metathorax, and first six abdominal segments, with a few scattered setae out of band, sometimes increased number in sixth; varying from separate to connected by more than one row with anterior tergal group in mesothorax and metathorax Supraspiracular divided in mesothorax and metathorax; usually continuous in first six abdominal segments but sometimes divided into two groups; generally extending caudad to anterior row of posterior tergal band in first six abdominal segments, sometimes extending to posterior row in fifth and sixth abdominal segments; separated or coalesced with anterior tergal band in first six abdominal segments, separated in seventh; those of seventh elongated, usually ten or more, coalesced with posterior tergal band. Infraspiracular separated into

two groups or united in mesothorax and metathorax, number generally not greatly reduced in any abdominal segments. Number of pedal setae not greatly reduced in any abdominal segments. Anterior sternal setae numerous, about four to six rows in mesothorax, about five to seven in central region of metathorax, not coalesced with posterior sternal in mesothorax, wide region in central part of band projecting caudad as a point, coalesced with posterior sternal in metathorax or projecting caudad in central region of band as a point in close proximity to posterior sternal group. Posterior sternal of mesothorax and metathorax in two groups but united at anterior ends. Seventh abdominal sternal separated into two groups or weakly continuous. Body setae long and stout.

*Donacia flavipes* Kirby

Egg (Pl I, Fig 11)

Egg

*Size* — Length, 0.84–0.98 mm, average of 30 eggs, 0.91 mm; width, 0.43–0.47 mm; average of 30 eggs, 0.45 mm. No apparent change in size during development.

*Shape* — Oval, chorion very thin, easily broken, apparently smooth, micropyle not visible, no gelatinous covering.

*Color* — Yolk white. Larva in egg, white, head and dorsal part of thoracic segments brown, two brown caudal spines, usually two rows of five black ocelli, three in front row and two in back, number sometimes varying because of fusion of ocelli.

*Location* — Deposited singly in air spaces of *Scirpus americanus* and *Typha latifolia*, in portion of plant projecting out of water, ovipositor puncture in plant parallel with edge of culm or leaf.

LARVAE

General features (Pl II, Fig 23)

Eruciform, 10–13 mm long at time of formation of cocoon, gradually decreasing in diameter anteriorly and posteriorly from middle of body, abdominal segments 8, 9, and 10 short, capable of extending beyond apices of caudal spines, caudal spines projecting ventrad. Legs of moderate size. White.

Ocelli

Five, number sometimes varying because of fusion of ocelli; two rows, three in front row and two in back; black.

**Mandible (Pl III, Figs 34-35)**

Flat, triangular, about as long as width of base. Two apical teeth, outer one round to bluntly pointed and curving weakly toward cutting edge, inner one round or bluntly pointed, usually not extending mediad of the cutting surface. Two setae; one just below mid-point of lateral surface, the other on dorsal surface just distad of neck of condyle. Condyle tilted strongly laterad, unevenly rounded, extremely thick-necked, on basal part of ventral side. Lateral surface approximately straight, curve usually only in region of outer tooth, beak portion serving as extensor muscle attachment, a continuation of remaining part of lateral surface. Cutting edge approximately straight, region just proximad of inner tooth usually with weak denticles, sometimes weakly concave. Border of basal end between condyle and cutting surface straight or curved, when curved having long convex region.

**Frons (Pl IV, Fig 57)**

Pentagonal, distance between lateral angles at least one fifth shorter than that between occipital angle and mid-anterior point; posterolateral edge longer than distance between lateral angles and approximately straight in anterior two thirds, width usually narrowed in posterior third, occipital point sharp and narrowed slightly, anterior angles closer to  $120^\circ$  than to  $100^\circ$ , tip of angle often sharp; heavily sclerotized anterolateral band bending strongly laterad, straight to weakly curved. Four long and six short setae. Two pit-like structures.

**Labrum (Pl V, Fig. 68)**

Three-sided, approximately one third wider than long, apparently no separate posterolateral wing; anterior and posterior sides usually continuously curved, anterior margin sometimes somewhat straightened, region between angular setae often equipped with small indentations, heavily sclerotized ventral lateral band continuing beyond lateral setae and following curvature of lateral border. Eight marginal setae; angular longest and projecting medially; second shorter than angular and longer than third, projecting medially, fourth sometimes as long as third; second sometimes equidistant from third and angular, distance between setae of fourth pair greater than that between third and fourth pairs. Six discal setae; proximal longest; median setae lateral and slightly posterior to



distal, distal setae about as long as third marginal and close to third and fourth marginal. Two lateral setae, lateral and in line with or slightly anterior to proximal. Four pitlike structures; one pair posterior and lateral to distal setae, the other pair posterior and lateral to proximal. All setae tapering evenly to a point; distal setae stout. Heavily sclerotized band extending from third and fourth marginal setae to join thicker sclerotized area near proximal setae; all discal setae in thinly sclerotized region.

#### **Lacinia (Pl VI, Fig. 79)**

Short, needle-shaped portion approximately one third as long as bow-shaped portion; chitinous process about four to five times longer than needle-shaped portion. No hairlike projections.

#### **Chitinous bow of labium (Pl III, Fig. 46)**

Semicircular, usually without irregularities.

#### **Caudal spine (Pl VI, Fig. 90)**

Short, a line from posteroventral end of basal part to apex of hook one fifth to one third longer than basal part; hook-shaped portion four to six times as long as soft-walled oval space enclosing spiracle. Weakly curved, tapering evenly to point.

#### **Body setae (Pl X, Fig. 101)**

Anterior tergal setae numerous and not widely separated, four to six rows in first seven abdominal segments, three to six rows in mesothorax and metathorax, three definite groups in mesothorax, metathorax, and first six abdominal segments, central groups connected by one or two rows of setae in mesothorax, metathorax, and first three abdominal segments, sometimes separated in mesothorax and metathorax, connected by one to three rows in abdominal segments 4, 5, and 6, one definite band in seventh segment, well over thirty setae, usually between forty and sixty. Posterior tergal setae numerous and not widely separated, four to six rows in first six abdominal segments with the band often reduced between central area and lateral extremities, three to six rows in mesothorax and metathorax; usually coalescing broadly with anterior tergal band in mesothorax and metathorax. Supraspiracular groups in mesothorax and metathorax separated or coalesced; generally extending caudad to posterior row of posterior tergal band in all abdominal segments, seventh continuous with posterior tergal band, sixth continuous or

weakly separated from posterior tergal band; separated or connected with anterior tergal band in first six abdominal segments, connected in seventh, setae numerous in seventh, more than ten. Infraspicular usually not separated in mesothorax and metathorax; number somewhat reduced in seventh segment. Generally fewer pedal setae in seventh; occasionally coalescing with some abdominal sternal setae. Anterior sternal of mesothorax and metathorax a continuous row, definitely coalesced to posterior sternal in metathorax, coalesced or separated in mesothorax. Posterior sternal divided but connected at anterior ends in mesothorax and metathorax. Sternal of seventh abdominal usually a continuous band, sometimes weakly divided. All body setae short and stout.

## KEY TO EGGS OF THE DONACINI STUDIED

- 1 (6) Egg mass covered by plant tissue only on attached side; mass always submerged, on water lilies . . . . . 2
- 2 (5) Egg mass arranged in circle or part of circle around hole on under surface of leaf of *Nymphaea advena* or *Castalia odorata*, white, opaque or translucent . . . . . 3
- 3 (4) Gelatinous matrix opaque, exposed surface flat, on *Nymphaea advena* only . . . . . *Donacia proxima* Kirby, p. 257
- 4 (3) Gelatinous matrix translucent; exposed surface convex, on *Castalia odorata* only . . . . . *Donacia cincticornis* Newman, p. 260
- 5 (2) Egg mass irregular, on submerged part of peduncle of *Nymphaea advena* only; yellow; opaque . . . . . *Donacia placatrix* Lacordaire, p. 253
- 6 (1) Egg mass completely covered by plant tissue, either submerged, or on or in plant above water, when present on water lily, deposited between two floating leaves, on various aquatic plants . . . . . 7
- 7 (10) Egg mass deposited on or in emergent aquatic plants, above water surface . . . . . 8
- 8 (9) Eggs deposited singly in tissues of *Sorpus americanus* and *Typha latifolia*, yolk white, no gelatinous covering . . . . . *Donacia flavipes* Kirby, p. 284
- 9 (8) Eggs deposited between two parts of *Sagittaria latifolia* leaf, glued together by gelatinous matrix; yolk yellow . . . . . *Donacia aequalis* Say, p. 277
- 10 (7) Egg mass deposited on submerged parts of emergent plants or between leaves of floating aquatic plants . . . . . 11
- 11 (12) Eggs deposited between two floating leaves held together by gelatinous mass; on numerous aquatic plants, such as *Polygonum amphibium*, *Polygonum hydropiperoides*, *Sparganium angustifolium*, *Sparganium diversifolium*, and *Nymphaea advena* . . . . . *Donacia subtilis* Kunze, p. 274

- 12 (11) Eggs deposited on submerged parts of aquatic plants, not between floating leaves 13
- 13 (14) Gelatinous envelopes covering eggs yellow, on inner sides of submerged stipules of *Potamogeton natans*  
*Haemonia nigricornis* Kirby, p 250
- 14 (13) Gelatinous envelopes covering eggs white, on submerged parts of various plants 15
- 15 (20) Eggs laid in single row between sheath and stem of *Scirpus* or *Phragmites* 16
- 16 (17) Egg mass on *Phragmites communis* *Donacia pubicollis* Suffrian, p 280
- 17 (16) Egg mass on *Scirpus occidentalis* 18
- 18 (19) Four ocelli showing through chorion before hatching, width of egg mass, 0.43-0.58 mm *Donacia pubescens* Le Conte, p 267
- 19 (18) Five ocelli showing through chorion before hatching, width of egg mass, 0.58-0.73 mm *Donacia quadricollis* Say, p 270
- 20 (15) Eggs laid in irregular mass between submerged parts of aquatic plants, but not on *Scirpus* or *Phragmites*, collected between stipules and stem of *Potamogeton natans* and between two submerged leaves of *Sparganium angustifolium*  
*Donacia hirticollis* Kirby, p 263

## KEY TO LARVAE OF DONACIINI STUDIED

- 1 (6) Hook-shaped portion of caudal spine nine or more times as long as soft-walled oval space enclosing spiracle; on water lilies 2
- 2 (3) Hook-shaped portion of caudal spine serrate at tip; on *Nymphaea advena* only *Donacia proxima* Kirby, p 257
- 3 (2) Hook-shaped portion of caudal spine not serrate at tip, on *Nymphaea advena* and *Castalia odorata* 4
- 4 (5) Anterior tergal setae of seventh abdominal segment sparse, fewer than twenty, distance between occipital region and mid-anterior point of frons as long as distance between lateral angles; occipital region of frons long and narrow, caudal spine strongly curved, on *Nymphaea advena* only  
*Donacia piscatrix* Lacordaire, p 253
- 5 (4) Anterior tergal setae of seventh abdominal segment numerous, more than twenty; distance between lateral angles of frons distinctly longer than distance between occipital region and mid-anterior point, occipital region not long and narrow; caudal spine moderately curved; on *Castalia odorata* only  
*Donacia cincticornis* Newman, p 260
- 6 (1) Hook-shaped portion of caudal spine less than eight times as long as soft-walled oval space enclosing the spiracle; on various aquatic plants other than water lilies 7
- 7 (8) Distance between occipital region and mid-anterior point of frons at least one fifth greater than distance between lateral

angles, labrum three-sided, needle-shaped portion of lacinia about one third as long as bow-shaped portion, no hairlike projections on lacinia, on *Scirpus americanus*, *Eleocharis palustris* var *major*, and *Typha latifolia* *Donacia flavipes* Kirby, p 284

- 8 (7) Distance between occipital region and mid-anterior point of frons not at least one fifth greater than distance between lateral angles; labrum five-sided, needle-shaped portion of lacinia at least one half as long as bow-shaped portion, hairlike projections on lacinia 9
- 9 (10) Tergum of seventh abdominal segment broadly pointed posteriorly and composed of dorsal and ventral portions, green, on *Potamogeton natans* *Haemonia nigricornis* Kirby, p 250
- 10 (9) Tergum of seventh abdominal segment smoothly rounded laterally and not composed of dorsal and ventral portions, cream or white 11
- 11 (14) Anterior sternal setae of metathorax coalescing with posterior sternal setae or composed of five or more rows of setae in mid-ventral line which converge caudad to form a point, on *Phragmites* and *Scirpus* 12
- 12 (13) Supraspiracular setae of seventh abdominal segments coalesced with anterior tergal setae, outer apical tooth of mandible pointed, larva 9-11 mm. long at time of formation of cocoon, on *Scirpus occidentalis* *Donacia pubescens* Le Conte, p 267
- 13 (12) Supraspiracular setae of seventh abdominal segments not coalesced with anterior tergal setae, outer apical tooth of mandible round, larva 13-16 mm. long at time of formation of cocoon, on *Phragmites communis* *Donacia pubicollis* Suffrian, p 280
- 14 (11) Anterior sternal setae of metathorax not coalescing with posterior sternal setae, usually composed of one to three rows in metathorax, rarely four complete rows in central region, the latter not converging caudad to form a point 15
- 15 (16) Supraspiracular setae extending caudad to posterior row of posterior tergal band of setae in first six abdominal segments, anterior and posterior tergal setae usually broadly coalesced in mesothorax and metathorax, on *Sagittaria latifolia*, *Sparganium diversifolium*, *Glyceria borealis*, *Sparganium angustifolium*, and *Potamogeton natans* *Donacia hirticollis* Kirby, p 268
- 16 (15) Supraspiracular setae not extending caudad to posterior row of posterior tergal band of setae in first six abdominal segments, anterior and posterior tergal setae usually not coalesced in mesothorax and metathorax, sometimes connected by one row 17
- 17 (18) Second, third, and fourth marginal setae approximately equally distributed along entire anterior edge of labrum, needle-shaped portion of lacinia approximating length of bow-shaped portion; chitinous bow of labium definitely V-shaped; supraspiracular setae usually separated into two groups in first six abdominal segments; on *Sagittaria latifolia* and *Sagittaria arifolia* *Donacia aequalis* Say, p 277

- 18 (17) Second, third, and fourth marginal setae grouped near middle of labrum, needle-shaped portion of lacinia one fifth to one third shorter than bow-shaped portion, chitinous bow of labrum not strongly V-shaped, supraspiracular setae of first four abdominal segments usually not separated into two groups; on *Scirpus*, *Sparganium*, *Typha*, *Sagittaria*, and *Pontederia* 19
- 19 (20) Mid-posterior projection of labrum long and prominent, setae on labrum stout, second, third, and fourth marginal setae of labrum equal in size and usually equidistant, proximal pitlike structure of labrum caudad of proximal seta, mandible with serrate ridge, inner apical tooth often short and round, seventh abdominal segment often with more than twenty anterior tergal setae, on *Scirpus occidentalis* *Donacia quadricollis* Say, p 270
- 20 (19) Mid-posterior projection of labrum short, setae on labrum thin, second marginal setae of labrum usually slightly longer than third, distance between second and third setae greater than that between third and fourth, proximal pitlike structure generally located lateral to proximal seta, mandible with definite denticles, inner tooth well developed, seventh abdominal segment often with fewer than twenty anterior tergal setae, on *Sparganium diversifolium*, *Sparganium angustifolium*, *Typha latifolia*, *Sagittaria latifolia*, *Pontederia cordata*, and *Sparganium eurycarpum* *Donacia subtilis* Kunze, p 274

## SUMMARY

(1) Eggs and larvae of eleven species of *Donacium* occurring in the region of Douglas Lake, Cheyebogan County, Michigan, are described and figured, six of them for the first time. Five species which had previously been studied by Sanderson (1900) and MacGillivray (1903) are here reconsidered.

(2) Keys for identifying both eggs and larvae of these species are presented.

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## LITERATURE CITED

- BÖVING, A. G. 1910. Natural History of the Larvae of Donacinae. *Int. Rev. ges. Hydrobiol. Hydrogr., Biol. Suppl.* 1: 1-108. 7 pls., 70 figs.
- MACGILLIVRAY, A. D. 1903. Aquatic Chrysomelidae and a Table of the Families of Coleopterous Larvae. *New York State Mus., Bull.* 68, *Entomol.* 18: 288-327. 12 pls.
- SANDERSON, E. D. 1900. The Larvae of *Donacia piscatrix*, Lac., and *crassipes*, Fab. *Can. Entomol.*, 32: 249-263. 29 figs.

**PLATES I-X**

## ABBREVIATIONS USED IN PLATES

a <sup>1</sup> -a <sup>7</sup>	abdominal segments 1-7	ms	medial seta of labrum
alb	anterolateral sclerotized band of frons	mst	mesothorax
as	angular seta of labrum	mt	metathorax
ast	anterior sternal setae of thorax	nc	niche of lacinia
at	anterior tergal setae	na	needle-shaped portion of lacinia
bs	bow-shaped portion of lacinia	or	occipital region of frons
cp	chitinous process of lacinia	pds	pedal group of setae
ds	distal seta of labrum	pr	posterior tergal setae
hp	hairlike projections on lacinia	ps	proximal seta of labrum
is	infraspiracular group of setae	pst	posterior sternal setae of thorax
lg	leg	sp	spiracle
ls	lateral seta of labrum	ss	supraspiracular group of setae
m <sup>2</sup> -m <sup>4</sup>	marginal setae 2-4 of labrum	st	sternal setae

## EXPLANATION OF PLATE I

### Egg masses

(Enlargements indicated by scales)

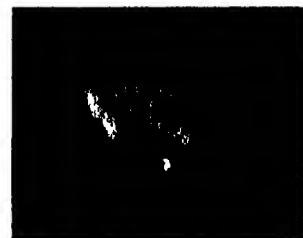
- FIG 1 *Haemonia nigricornis* Kirby  
 FIG 2 *Donacia piscatrix* Lacordaire  
 FIG 3 *D proxima* Kirby  
 FIG 4 *D cincticornis* Newman  
 FIG 5 *D pubicollis* Suffrian  
 FIG 6 *D pubescens* Le Conte  
 FIG 7 *D hirticollis* Kirby  
 FIG 8 *D subtilis* Kunze  
 FIG 9 *D aequalis* Say  
 FIG 10 *D quadricollis* Say  
 FIG 11 *D flavipes* Kirby  
 FIG 12 *D aequalis* Say on leaf of *Sagittaria latifolia*



1



2



3



4



5

1 cm.



6



7



8



9

1 cm



10

5 mm.



11

2.5 mm.



12



## EXPLANATION OF PLATE II

### Larvae

(All photographs on same scale)

- FIG. 13 *Haemonia nigricornis* Kirby
- FIG. 14 *Donacia piscatrix* Lacordaire
- FIG. 15 *D. proxima* Kirby
- FIG. 16 *D. cincticornis* Newman
- FIG. 17 *D. lurticollis* Kirby
- FIG. 18 *D. pubescens* Le Conte
- FIG. 19 *D. quadricollis* Say
- FIG. 20 *D. subtilis* Kunze
- FIG. 21 *D. aequalis* Say
- FIG. 22 *D. pubicollis* Suffrian
- FIG. 23 *D. flavipes* Kirby



13



14



15



16



17



18



19



20



21



22



23

1 cm



## EXPLANATION OF PLATE III

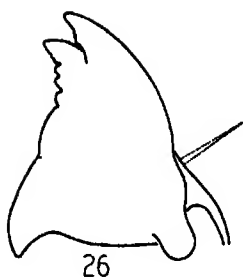
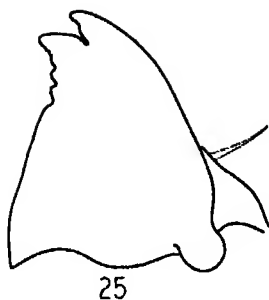
(All drawings on same scale)

### Ventral views of mandibles

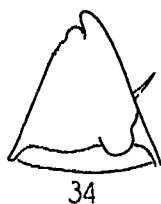
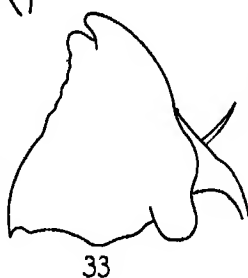
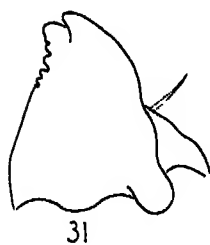
- FIG 24 *Haemonia nigricornis* Kirby  
FIG 25 *Donacia piscatrix* Lacordaire  
FIG 26 *D proxima* Kirby  
FIG 27 *D cincticornis* Newman  
FIG 28 *D hirticollis* Kirby  
FIG 29 *D pubescens* Le Conte  
FIG 30 *D quadricollis* Say  
FIG 31 *D subtilis* Kunze  
FIG 32 *D aequalis* Say  
FIG 33 *D pubicollis* Suffrian  
FIG 34 *D flavipes* Kirby  
FIG 35 *D flavipes* Kirby

### Chitinous bows of labia

- FIG 36 *Haemonia nigricornis* Kirby  
FIG 37 *Donacia piscatrix* Lacordaire  
FIG 38 *D proxima* Kirby  
FIG 39 *D cincticornis* Newman  
FIG 40 *D hirticollis* Kirby  
FIG 41 *D pubescens* Le Conte  
FIG 42 *D quadricollis* Say  
FIG 43 *D subtilis* Kunze  
FIG 44 *D aequalis* Say  
FIG 45 *D pubicollis* Suffrian  
FIG 46 *D flavipes* Kirby



0.1mm



0.2mm

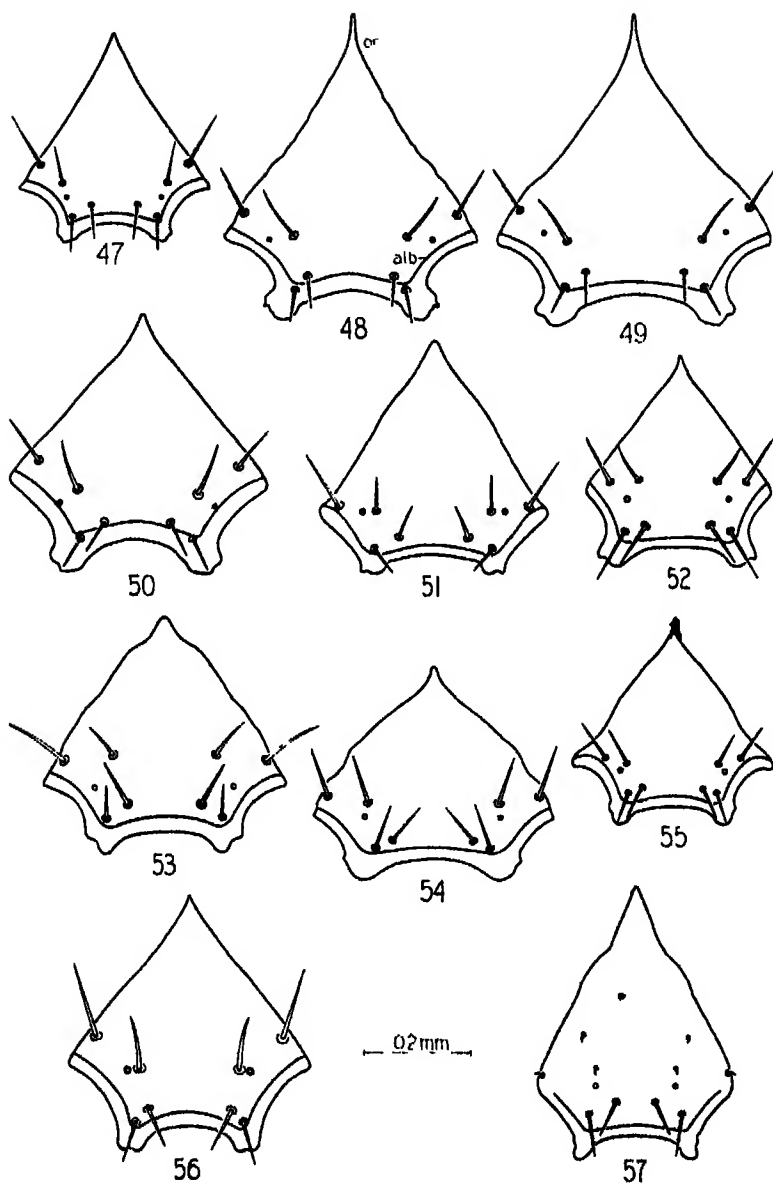


## EXPLANATION OF PLATE IV

Dorsal views of frontes

(All drawings on same scale)

- FIG 47 *Haemonia nigricornis* Kirby
- FIG 48 *Donacia piscatrix* Lacordaire
- FIG 49 *D proxima* Kirby
- FIG 50 *D cincticornis* Newman
- FIG 51 *D hirticollis* Kirby
- FIG 52 *D pubescens* Le Conte
- FIG 53 *D quadricollis* Say
- FIG 54 *D subtilis* Kunze
- FIG 55 *D aequalis* Say
- FIG 56 *D pubicollis* Suffrian
- FIG 57 *D flavipes* Kirby

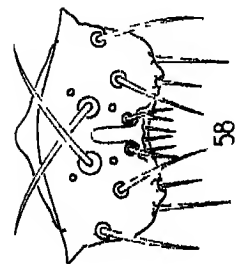


## EXPLANATION OF PLATE V

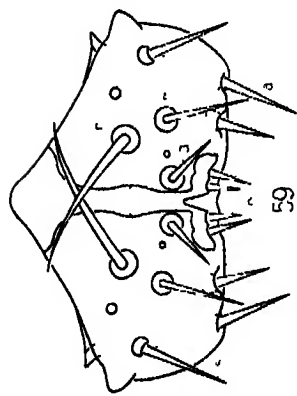
Dorsal views of labra

(All drawings on same scale)

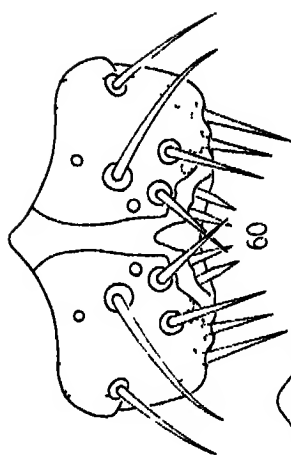
- FIG 58 *Haemonia nigricornis* Kirby
- FIG 59 *Donacia piscatrix* Lacordaire
- FIG 60 *D proxima* Kirby
- FIG 61 *D cincticornis* Newman
- FIG 62 *D hirticollis* Kirby
- FIG 63 *D pubescens* Le Conte
- FIG 64 *D quadricollis* Say
- FIG 65 *D subtilis* Kunze
- FIG 66 *D aequalis* Say
- FIG 67 *D pubicollis* Suffrian
- FIG 68 *D flavipes* Kirby



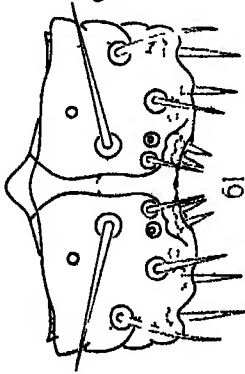
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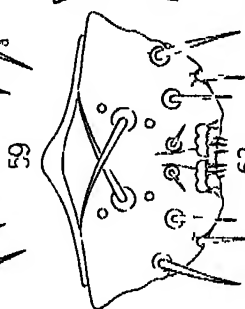
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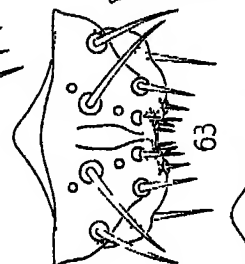
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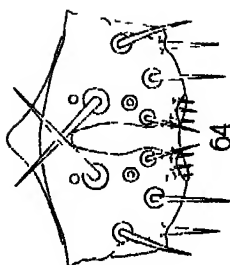
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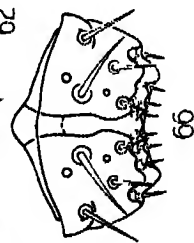
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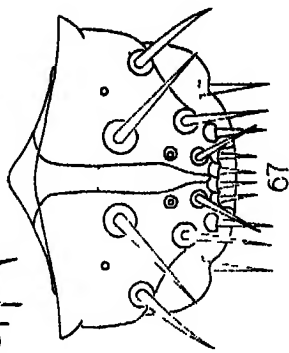
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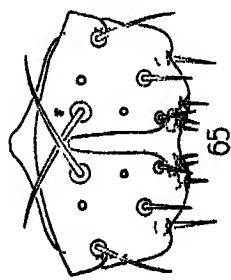
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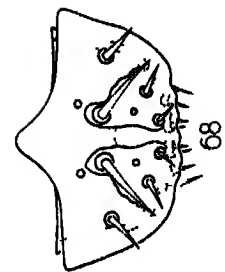
66



67



65



68

0.0 mm.



## EXPLANATION OF PLATE VI

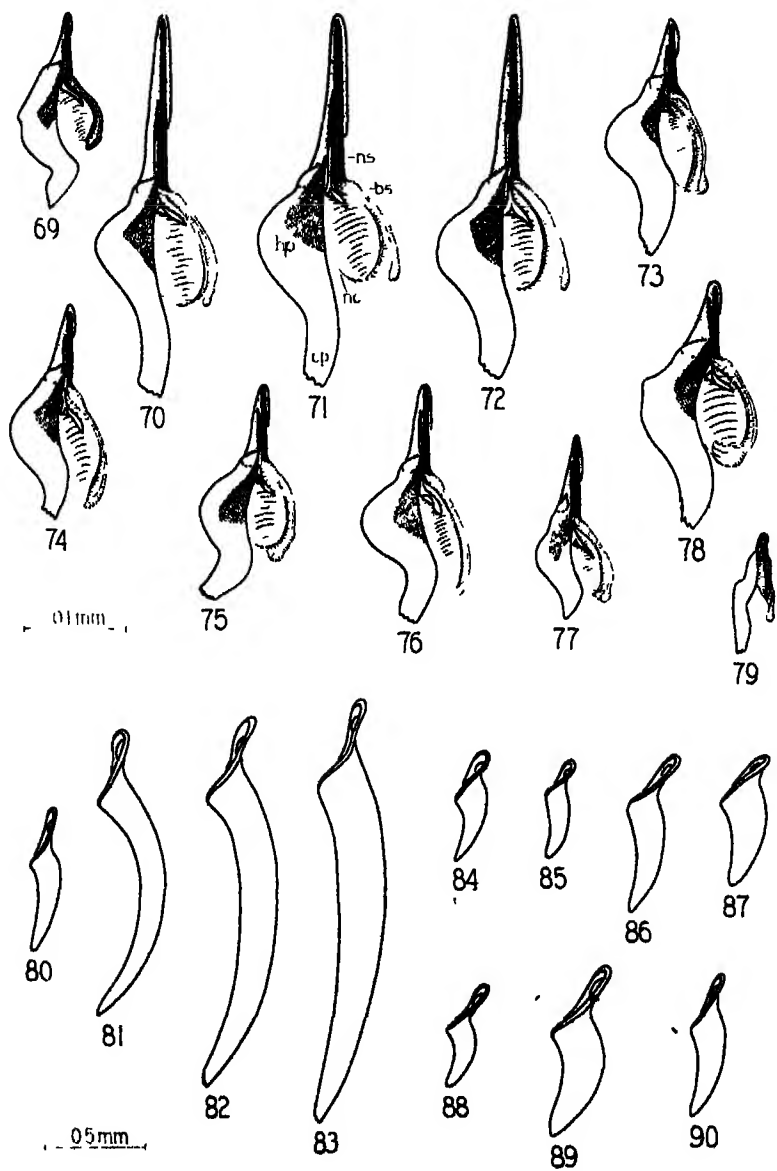
(All drawings on same scale)

### Dorsolateral views of laciniae

- FIG 69 *Haemonia nigricornis* Kirby
- FIG 70 *Donacia piscatrix* Lacordaire
- FIG 71 *D proxima* Kirby
- FIG 72 *D cincticornis* Newman
- FIG 73 *D hirticollis* Kirby
- FIG 74 *D pubescens* Le Conte
- FIG 75 *D quadricollis* Say
- FIG 76 *D subtilis* Kunze
- FIG 77 *D aequalis* Say
- FIG 78 *D pubicollis* Suffrian
- FIG 79 *D flavipes* Kirby

### Lateral views of caudal spines

- FIG 80 *Haemonia nigricornis* Kirby
- FIG 81 *Donacia piscatrix* Lacordaire
- FIG 82 *D proxima* Kirby
- FIG 83 *D cincticornis* Newman
- FIG 84 *D hirticollis* Kirby
- FIG 85 *D pubescens* Le Conte
- FIG 86 *D quadricollis* Say
- FIG 87 *D subtilis* Kunze
- FIG 88 *D aequalis* Say
- FIG 89 *D pubicollis* Suffrian
- FIG 90 *D flavipes* Kirby





mst    mt    a<sup>1</sup>    a<sup>2</sup>    a<sup>3</sup>    a<sup>4</sup>    a<sup>5</sup>    a<sup>6</sup>    a<sup>7</sup>

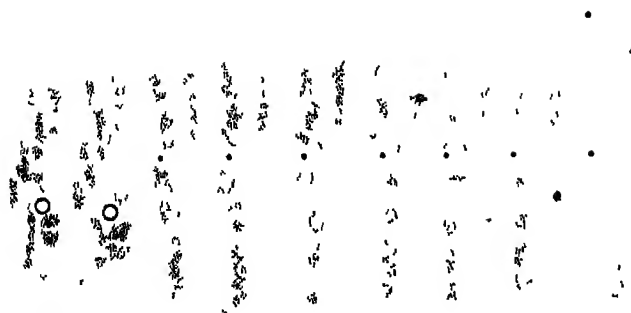
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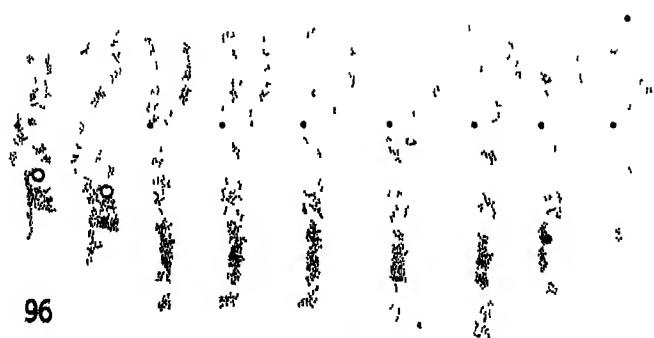
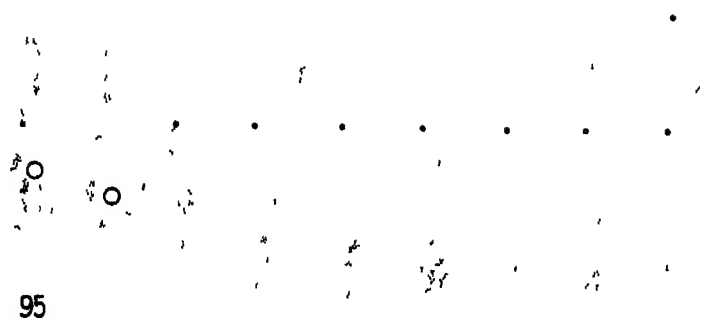
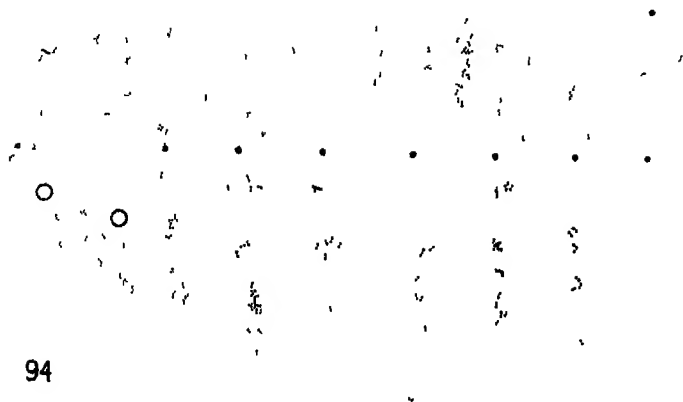
Body setae

FIG. 91. *Haemonia nigricornis* Kirby

FIG. 92. *Donacia piscatrix* Lacordaire

FIG. 93. *D. proxima* Kirby





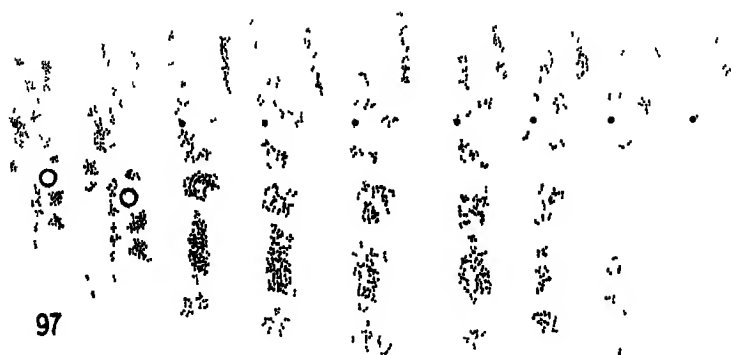
Body setae

FIG. 94. *Donacia cineticornis* Kirby

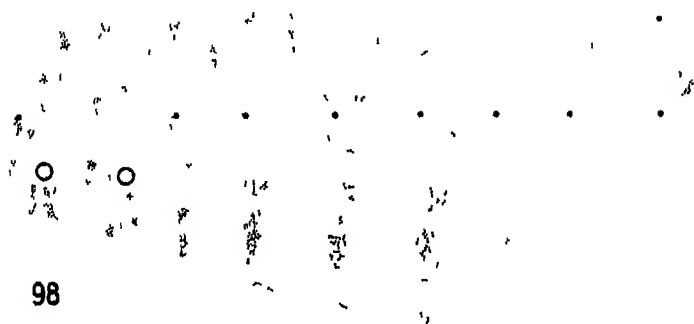
FIG. 95. *D. hirticollis* Kirby

FIG. 96. *D. pubescens* Le Conte

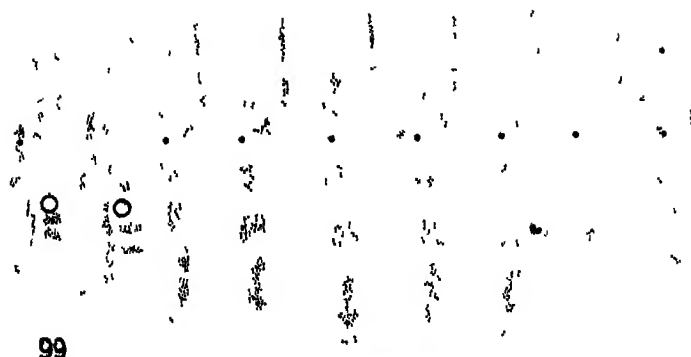




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98



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Body setae

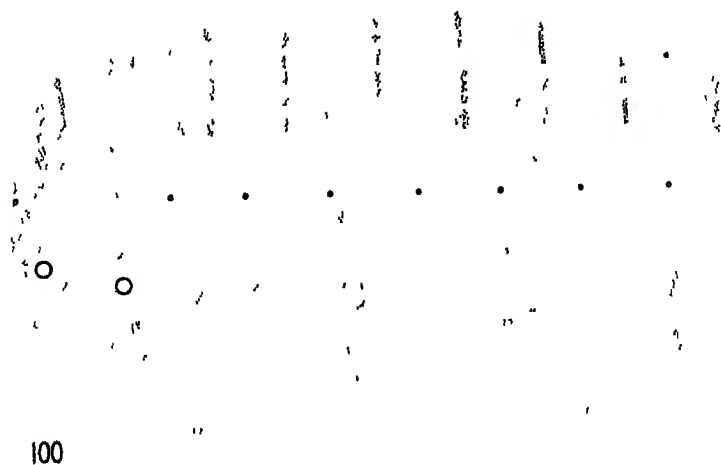
FIG. 97. *Denecia quadricollis* Say

FIG. 98. *D. subtilis* Kunze

FIG. 99. *D. acqualis* Say







Body setae

FIG. 100 *Donacia pubicollis* Suffrian

FIG. 101. *D. flavipes* Kirby



# THE CRANIUM OF A FRESH-WATER SHEEPS- HEAD FROM POSTGLACIAL MARL IN CHEBOYGAN COUNTY, MICHIGAN

CARL L. HUBBS

**T**HERE are fields of research in which even fragments of concrete data are eagerly seized upon. This is especially true of subjects like zoogeography, in which conclusions can ordinarily be drawn only from circumstantial evidence. In recent attempts to trace the postglacial redispersal of fishes in North America (see especially Greene, 1935) the lack of purely objective data on the occurrence of fish species in given regions has been a particular deterrent to the drawing of precise conclusions. It is with much satisfaction, therefore, that I am able to record with certainty the ancient, postglacial, occurrence of the fresh-water sheepshead, *Aplodinotus grunniens* Rafinesque, in the waters of Burt Lake, Michigan, or in one of its postglacial precursors.

While digging a boat well at Burt Lake during the summer of 1937 Mr. J. H. Greenman uncovered a remarkably well preserved cranium of *Aplodinotus* (Pl. I). He specifies that the skull was found thirty feet from the water's edge and exactly six feet below the surface of the level ground (which here lies only a few feet above the lake level). It was under "about two feet of black muck or turf and about four feet of marl, right at the bottom of the marl where the marl bed lay on solid red clay." A coating of white marl remains in some of the cavities of the skull bones. In the unpublished soil survey of Cheboygan County, according to Lee R. Schoenmann (personal communication), the superficial "two feet of black muck or turf," which here overlies the marl, has been identified as a local area of Edwards muck associated with Granby sand.

The location of the discovery is on Greenman Point, near the north end of the east shore of Burt Lake, in Section 14, T. 36 N.,

R 3 W (Burt Township), Cheboygan County, Michigan By straight line the site lies thirteen miles inland from the Straits of Mackinac at Cheboygan Burt Lake, a large body of water, is one of the main elements of the "Inland Waterway,"<sup>1</sup> which during most of post-glacial time constituted a strait connecting Lakes Michigan and Huron (Leverett and Taylor, 1915)

As to the age of this semifossil fish skull, I have consulted a number of scientists who are conversant with the region, including the glacial geologists Frank Leverett and George M Stanley, the limnologist P S Welch, and the land and economic survey expert Lee R Schoenmann All agree that the sheepshead in question must have lived in postglacial time, certainly many centuries ago Without a specific field examination, however, no one is ready to correlate definitely the occurrence of the fish with any of the series of post-glacial lakes Dr Stanley suggests, however, that, because of the frequent finding of such marl and peat deposits of Nipissing age not far above present lake levels and the paucity of such materials in Algonquin deposits, a correlation with Lake Nipissing seems most plausible. The penetration of foramina in the bones by marl-preserved root or stem fibers makes it seem virtually certain that the skull was laid down in shallow water and, therefore, during neither of the high levels of Lake Algonquin

The occurrence of *Aplodinotus grunniens* in the Inland Waterway during postglacial time takes on added significance in view of the almost certain absence of the species in these waters at the present time The sheepshead is an essentially southern species, as Barney (1926) has pointed out in detail (I have taken it as far south as the Río de la Pasión, a tributary of the Río Usumacinta in El Petén, Guatemala) It is rather common in southern Lake Michigan, in Lake Erie, and in Saginaw Bay of Lake Huron, and there is one published record for the mouth of the Au Sable River, which enters Lake Huron north of Saginaw Bay Records of the commercial fish catch (made available by Dr Ralph Hile of the United States Bureau of Fisheries) indicate an occasional straggling northward as far as the Beaver Islands in Lake Michigan, along the northern shores of Lake Huron in Michigan, and even into St Martin Bay on the north

<sup>1</sup> See Chart of Inland Route of Navigation, Michigan, from Cheboygan, to Little Traverse Bay, Including Petoskey and Harbor Springs, 1930 (War Department, Lake Charts, Cat No 66).

side of the Straits of Mackinac<sup>2</sup> It is not surprising, therefore, to find proof of the penetration of the species into the location of Burt Lake, particularly at a time when the Inland Waterway was a broad, shallow, and probably turbid strait, providing conditions which would be favorable to the species At present the sheephead occurs even much farther north, in cool, shallow, and often turbid waters (Barney, 1926, Dymond and Hart, 1927) Its presumed use of the southern outlets of the glacial Great Lakes (Barney, 1926, Greene, 1935) is confirmed

The postglacial cranium of *Aplodinotus grunniens* (Pl I), measuring 156 mm from the tip of the vomer to the end of the supra-occipital crest, represents a rather large specimen of the species as compared with the usual size of present-day adults The bones of the species found in Indian burials and middens<sup>3</sup> prove, however, that vastly larger sizes were attained in prehistoric time

When this beautifully preserved skull is compared with that of a Recent specimen from Lake Erie, only slight differences are apparent (Pl I) The greater thickening and the coarser sculpturing of the bones are attributable to the age of the postglacial individual (about twenty years, as determined from the winter lines on the membrane bones) Owing to the marked bilateral asymmetry of the postglacial skull and of the variation shown by Recent skulls, differences in the foramina and in details of sculpturing probably lose all significance

The discoverer of the postglacial *Aplodinotus* cranium, Mr J H Greenman, has very kindly deposited the specimen in the University of Michigan Museum of Zoology We are grateful to Dr Max M Peet of Ann Arbor, a summer neighbor of Mr. Greenman, for recognizing the scientific value of the specimen and for bringing it to the Museum with information on the remarkable find

#### UNIVERSITY OF MICHIGAN

<sup>2</sup> There is no evidence, however, to confirm the expectation of Barney (1926) that the species will be found to occur in Lake Superior

<sup>3</sup> A study of these remains has been in progress for some time.

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## CRANIA OF POSTGLACIAL AND RECENT SHEEPSHLEAD

Two crania are shown, each in posterior, dorsal, and lateral aspect. The larger, postglacial skull is 156 mm long from tip of vomer to end of supraoccipital crest. The smaller, Recent cranium, 122 mm long, was prepared from a Lake Erie specimen. Photographs, to the same scale, by F. W. Ouradnik.





# NOTES ON THE BIRDS OF ZANKSKAR AND PURIG, WITH APPENDIXES GIVING NEW RECORDS FOR LADAKH, RUPSHU, AND KULU

WALTER KOELZ

**Z**ANKSKAR is one of the loftiest inhabited districts on earth. It is also one of the remotest areas of the Indian Empire. Few ornithologists have ever visited it, and the only records I can find of its birds are of those collected by Dr Stoliczka and Mr Osmaston. The former gives 1866 and 1868 as dates of collection of two species of birds at Padum,<sup>1</sup> and A. von Pelzeln<sup>2</sup> records two species from Parkachen and Rangdum Gompa. Mr Osmaston's data<sup>3</sup> are more numerous.

I passed through the district from Kargi La to Rangdum and thence across Pensi La to Padum and Shingkun La (often written Shingo), on the main Himalayan Ridge, into Lahul between September 9 and October 1, 1931, and from Shingkun La to Rangdum and then down the Rangdum River through Purig to Kargil from July 11 to 27, 1933. On each occasion the purpose of my visit was other than ornithological, and birds were collected only as opportunity offered. In Purig I spent but three days and had no time to turn from the road. It appears, however, in comparison with the bird population of similar districts, that my collection is probably fairly representative of the species likely to occur, and since even an imperfect record is better than none, I present my notes. They supplement our meager knowledge of the bird life of the high altitudes of the Himalayas, to the furtherance of which there is room for the energies of many workers. Habitats in the mountains are quite

<sup>1</sup> Stoliczka, F., "Ornithological Observations in the Sutlej Valley, N. W. Himalaya," *Journ Asiatic Soc Bengal*, 37: 62-63, 1868.

<sup>2</sup> von Pelzeln, A., "On the Species of Birds Collected by Dr Stoliczka in Tibet and the Himalayas," *Ibis*, 4: 302-321, 1868.

<sup>3</sup> Osmaston, B. B., "A Tour in Further Kashmir," *Journ Bombay Nat Hist Soc*, 34, No. 1: 108-134, 1930.

varied, and even in a tiny area great labor and much time are required to explore them all. In addition, the avian population of the mountains is of complex constitution, there are birds that remain permanently, some that spend only the summer or the winter, and others that are merely transients, and many of these have altitudinal preferences that may vary with the season. For this reason it may be expected that for many years to come careful observers will be adding names to the faunal lists that we now have.

The Districts of Zankskar and Pung lie against the backbone of the Himalayas, and an irregular flanking range shuts them off from the lofty great "North Plain" of Tibet. The winds from India become drier with each range they cross, so that they provide little precipitation for places beyond. The old glacial plain, especially in Zankskar, is therefore relatively well preserved and, being broad in places, furnishes cultivation sites that could support a much greater human population.

The character of the country varies considerably along the route from Lahul to Ladakh, and there are great changes in altitude. The route can be divided roughly into five stretches, according to the physical characteristics, each of which will be described in the succeeding paragraphs.

The road along the little stream that runs down from Shingkun La (elevation about 16,000 feet) to Padum (about 12,000 feet) is against the rounded worn mountain flanks, and winds up and down and in and out of the gorges of the little streams that drain some snowcap far back in the jumbled hills. The Great Pass was still under deep snow in mid-July, but by the end of the summer all snow and ice had melted except a little glacier that lies in a crevice at the side of the path. Plants grow abundantly below the Pass, where the influence of the reservoir of snow is felt. Thereafter the region is semi-arid and the pink-brown, dove-gray, and purple-black hill slopes are sprinkled with patches of green only near their crests. Along the river there is nothing lush but the fields of the few scattered villages that are passed before the oft-strengthened stream mouths into the Zankskar River at Padum, and the occasional patches of green that mark places where a brook joins the river. At Tetha a few willows are first seen, and in the villages below the junction of the Tsarup poplars put in their appearance. Rosebushes, some of them ten feet high, covered in summer with glorious pink blooms and in fall with

only little less attractive crimson hips, are sometimes common along the road, and there are a few small thickets of willow and tamarisk

The Zaskar River, which rises in mighty glaciers beside Pensí La, flows down a valley that for the high mountains is broad and open, and the view from Padum toward Pensí La is one of the finest in the province. The plain, at Padum a mile wide, fertile, and well watered, extends up to Abring, a stage below the pass. Occasional spurs are thrust out from the mountain side across the valley, and the river's course alternates between its broad gravelly bed of the plain and the narrow gorges it has cut through the obstructing walls. The mountains are still rounded and worn, with vegetation caps around their peaks. How rich this floral mantle is the ascent of Pensí La, about 16,000 feet high, discloses. At its foot there occur extensive willow thickets around copious streams and springs.

Across the Pass begins the Rangdum River that flows to join the Suru at Kargil. To Rangdum monastery (about 13,000 feet), and for five miles or more below, the valley is broad and bordered with springs that make the floor a water-soaked meadow of green. The valley of the tributary that comes down from Kangí La and Ling-shot and mouths at Rangdum is not marshy but remarkably rich in herbage, and Rangdum is thus the finest pasture ground in the whole district. Thickets of willow are numerous, and in July flowers glorify the whole landscape. A little primrose makes blocks of pink of even half an acre in the pattern of green. Settlements in this section are rare; in addition to the monastery they comprise only three small villages.

From Gyama Tongdze (12,200 feet) the road is up and down over old glacial drift against the now narrowed and rubble-strewn mountain walls. The stream is a torrent in its gorge. The last of the roses straggle along the foot of the mountains and on the patches of soil among and below the rubble hardy flowers make a cheerful showing in July. Traces of former settlements may be seen.

The District of Purig begins to be inhabited at Parkachen (about 11,000 feet), and from there to Sangu, about halfway to Kargil (about 8,900 feet), villages become increasingly common and cultivated patches are almost constantly in view. The river has here turned again to run against the great ridge, with its jagged peaks and sparkling glaciers, and the somber, weary, age-worn countenance of

the landscape changes for a brief space to one of freshness, exhilaration, and all-defying youth

Beyond Sangu the grandeur of the scenery passes, and the mountain slopes are drier than ever. Villages are less common, but two great oases lie in the course of the valley before it debouches at Kargil (about 8,900 feet). Tsaliko (9,400 feet) is the largest settlement in the district, and Guntung, a few miles below, is one of the thriftiest. After leaving Zankskar one finds the climate progressively milder with decreasing altitude, and the variety of crops increases. In these lower villages even potatoes, corn, and onions are occasionally grown, at Tsaliko there are, besides the now common groves of poplars and willows, a few apple trees, at Guntung mulberries and apricots may be seen.

Zankskar is a high mountain district, with a bird population akin to that of Spiti and high Lahul. Purig is ornithologically like Ladakh, and all its species occur in the Indus valley about Leh.

#### LIST OF SPECIES

##### *Corvus corax tibetanus* Hodgson

In 1933 ravens were observed at Kargiak and at all the towns passed in descending to Padum. A pair was seen at Abring and another at Bok below Pensu La and at Rangdum. The Zankskarais say there is one pair only at every village. In Purig one bird was seen at Parkachen and another at Tangola. A male was taken at Tetha in 1931 and a second at Mune in 1933.

##### *Corvus corone orientalis* Eversm

This species occurs from Tsaliko on down the valley. A specimen was taken at Kargil.

##### *Pica pica bactriana* Bp

Specimens were collected at Tangola on July 26, 1933, and the species was seen at most of the settlements below that place.

##### *Pyrhocorax pyrrhocorax himalayanus* (Gould)

These birds are common throughout Zankskar, they do considerable damage to the crops in the fall, when flocks gather in the grain fields. They were seen in Purig at Parkachen and Tangola. Specimens were collected in 1931 at Cha and in 1933 near Sem.

*Pyrhrocorax graculus forsythi* Stol

Three birds were seen around Lagong in 1931 No others were observed

*Oriolus oriolus* (L )

An oriole was seen at Guntung, Purig, on July 27, 1933

*Carduelis caniceps caniceps* Vigors

In 1931 this bird was common around Hamiling, in 1933, at Mune Specimens were taken at both places

*Serinus pusillus* (Pall )

This species is rather generally distributed in Zankskar In 1931 it was found about Tetha and Cha, in 1933, at Kargiak, Cha, and Abring Specimens were collected at all these places

*Erythrina rhodochlamys grandis* (Blyth)

In 1931 this bird was rather common around Cha and Tetha, where roses grew abundantly In 1933 it was found from Tetha to Burdun

*Erythrina rubicilla ebbs* Koelz

In 1931 several were seen at Cha, in 1933, only at Lagong and Kargiak Specimens were collected at all these places.

*Erythrina erythrina kubanensis* (Laubm )

This is a generally distributed bird in both districts and is found about all settlements The Lahul and Ladakh form is certainly not like that of the Eastern Himalayas, which is found in peninsular India in winter, and should not be known as *roseata*

*Pyrhospiza punicea humi* (Sharpe)

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The species seems to be very local and has been found in only three places below Shingkun La near Lagong, at Rangdum, and on Pensi La Specimens were collected at Lagong and Pensi La in both 1931 and 1933 In 1931 first-plumaged birds were taken on Pensi La on September 12. Males with swollen gonads were taken in female plumage in July

*Leucosticte nemoricola altaica* (Eversm )

In 1931 it was generally distributed in Zankskar in September  
In July of 1933 it was found from Lagong to Pensu La, but only  
singly or in family parties

*Leucosticte brandti haematopygia* (Gould)

Specimens of this were taken at Lagong, but it was not observed  
elsewhere.

*Montifringilla adamsi adamsi* (Adams)

A bird of high altitudes which is rather common around Lagong  
On July 14, 1933, birds in first plumage were flying

*Passer domesticus parkini* (Whistler)

Generally distributed, occurs around all villages

*Emberiza cia stracheyi* (Moore)

Specimens were taken in 1933 at Tetha, Cha, Munc, and Tangola  
It seems to be rare in both districts

*Emberiza icterica* (Eversm )

Only one was seen, a juvenile female taken at Cha on September  
24, 1931

*Emberiza buchanani* (Blyth)

A male was taken from three seen at Padum on September 17,  
1931

*Calandrella acutirostris acutirostris* (Hume)

This is a generally distributed bird in Zankskar, but I have no  
records for Purig In July, 1933, the birds were breeding and oc-  
curred only singly or in twos and threes; in September there were  
small flocks of from ten to fifteen

*Calandrella brachydactyla dukhunensis* (Sykes)

In 1931 from Hamling to Lagong flocks of fifty to several hundred  
were regularly seen Especially large flocks were found at Trangse  
This bird seems to be a regular fall migrant through the district;  
large flocks were found in Spiti in September, 1933.

*Alauda arvensis lhamarum* (Mein)

Generally distributed around cultivated places from Kargiak through both provinces, abundant at Padum First-plumaged young were taken at Sangu In 1931 skylarks were found from Abring to Cha, but since specimens are not available for comparison, I am not sure of their subspecific identification

*Eremophila alpestris longirostris* (Moore)

In summer larks were found generally throughout Zaskar and in Purig down to Tangola On July 10 and 11, 1933, birds in first plumage were taken at Lagong below Shingkun La In the fall they were rarer, and only occasional specimens were observed, except around Lagong

The distribution of the races *longirostris* and *elwesii* has often been discussed by ornithologists, and to the diversity of opinion I add mine, recognizing that it is not entitled to rank with those of Hellmayr, Meinertzhagen, Whistler, and others who have concerned themselves with the subject

Throughout Spiti, Lahul, and Zaskar I have found only one form, *longirostris* Beyond trans-Himalayan Lahul this form apparently extends to La Chhulung, where I collected five typical specimens from a large flock on August 22, 1933 There were no larks beyond that pass till one reached the More Plain, about ten miles below, and though no obvious barriers exist the very distinct *elwesii* occurs abundantly at the latter locality In Ladakh I have found few larks Above Tog on August 19, 1931, I took an adult female of *longirostris* Across the Indus Valley, near Tsultak, on August 1, 1931, I took a first-plumaged male of that race Beyond, along Pangong Tso, only *elwesii* occurs Birds of Debring, Tso Kar, Tso Morari, and Tsaka are of this form To judge from my observations, then, the dividing line of the two races runs from somewhere between Spiti and Rupshu, across La Chhulung to somewhere west of Taklang La, above Debring, to near Tsultak across Chang La. I have before me 36 specimens of *longirostris* taken in Lahul, Spiti, and Zaskar in 1933, and in previous years I have taken as many more from Lahul and Zaskar The type locality is Kulu, but larks probably occur there only on the Spiti and Lahul border Wings of 19 adult males, with the primary tips more or less frayed, measure 124 to 129 mm., of 11 adult females, 112 to 120 mm Of



*elwesii* I have 22 from Rupshu and Ladakh and have taken as many more in other years. Wing measurements of 5 adult males, 115 to 122 mm, of 7 adult females, 110 to 113 mm. In addition to a shorter wing, *elwesii* has a much shorter bill and pinker back. The first plumages are also different in the two forms.

Meinertzhagen (*Ibis*, Ser 12, 3 400 1927) lists under *longirostris* a number of specimens from near Tsultak that appear from the measurements to include representatives of both races, and it may be that there is a contact zone about Chang La. His Pangong and Tso Kar birds agree in measurements with mine. Meinertzhagen knew typical *elwesii*, and if he considered none of his Ladakh birds of that race, the specimens I call *elwesii* may be of an undescribed form.

*Anthus trivialis harringtoni* (Witherby)

This species was rather common at Cha in the grain fields between September 20 and 25, 1931, and several specimens were collected. It was also found sparingly on Pensu La on September 13, at Abring on September 15, and at Hamling the next day.

*Motacilla flava beema* (Sykes)

A specimen was taken at Rangdum on September 12 and one at Phe on September 16, 1931.

*Motacilla citreola calcarata* (Hodgson)

Generally distributed throughout Zaskaskar and most of Purig, where water occurs. A breeding female from Karsha has no yellow or black. Fully fledged young were found at Yuljuk on July 26, 1933.

*Motacilla alba alboides* (Hodgson)

Generally distributed like the last species. First-plumaged birds occurred at Seni on July 19, 1933. At Yuljuk on July 26 a female with a gray back was collected, it was mated to a typical black-backed male. Furthermore, it has a bill as small as in *personata* specimens. A similar bird with a longer bill was taken at Spitug, Ladakh, on August 7. Meinertzhagen is undoubtedly right when he says (*op cit*, p 406) that females of *alboides* cannot be separated from *personata* females on color alone. Though *alboides* is undoubtedly the breeding bird of Spiti, as it certainly is of Lahul, in September, 1933, I found only *personata* till I was halfway through the province.

*Tichodroma muraria* L

In 1931 specimens were taken at Reru and Cha. Two birds were seen at Tetha, two at Cha, and one at Abring in 1933

*Phylloscopus affinis* (Tick)

This species was found only at Bok, below Pensä La, where two males in much-worn plumage were taken on July 23, 1933, in the willow thicket

*Phylloscopus griseolus* (Blyth)

This warbler occurs sparsely throughout Zankskar, but I did not find it in Purig. Specimens were first taken at Lagong

*Phylloscopus collybitus sindeanus* (Brooks)

This is the common warbler of both districts, and it occurs around settlements and thickets wherever there is shelter. Full-fledged nestlings were taken in Purig. Through September individuals were still in the area

*Phylloscopus inornatus humi* (Brooks)

In September the species occurs not uncommonly in migration. The last specimen was taken at Cha on September 25, 1931

*Tribura major major* (Brooks)

Two were taken at Guntung, and there were others among the crops

*Sylvia althaea althaea* Hume

In September, 1931, the species was a common migrant at Tetha and Cha from the 18th to the 25th. In 1933 it was found first about six miles above Sangu and then on down the valley, especially around Hippophae thickets. Specimens were collected at the localities mentioned

*Sylvia curruca blythi* Ticeh & Whistler

An adult female was taken at Sarle on September 20, 1931

*Monticola solitaria longirostris* Blyth

An adult male was seen at Mune on July 18, 1933; one was taken at Sangu on the 26th and another at Guntung on the 27th. The

species apparently occurs locally in small numbers, as in the adjacent districts

*Myophonus coeruleus temminckii* Vigors

In 1931 a specimen was seen at Tetha on September 20 and one was taken at Cha a few days later. In 1933 a bird in first plumage was collected at Parkachen on July 25. No others were seen, but the species probably nests occasionally elsewhere in Purig.

*Oenanthe deserti oreophila* Oberh

Generally distributed in the valley floor as a breeding bird from Lagong to near Parkachen. Adults were much worn and juveniles were in first plumage. In September the species was still present in this situation, and most birds were in adult dress.

*Saxicola torquata przewalskii* (Pleske)

A male specimen was taken at Tetha on September 29, 1931. Wing measurement, 73 mm.

*Saxicola torquata maura* (Pallas)

Two females were taken at Cha, September 26, 1937. Wing measurements, 67 and 71 mm.

*Phoenicurus ochrurus phoenicuroides* (Moore)

Black redstarts were generally distributed, but not abundantly, on the way down to Rangdum in July, 1933. Adults were in badly worn plumage, the young were in first plumage. In September, 1931, the species was common at all localities, especially about villages.

*Charmarrornis leucocephala* (Vigors)

In 1931 one was taken at Cha. In 1933 specimens were seen at Cha, Mune, and Yuljuk.

*Luscinia pectoralis pectoralis* (Gould)

The species frequents thickets along springs and is rather common from below Pensí La to Shakkar below Rangdum. Six males were collected, and all are typical of this form. Nestlings able to fly were taken after July 22, 1933. This area was visited after September 11 in 1931, but no specimens were seen.

*Luscinia suecica abboti* Rich

A female in first plumage was taken at Seni, and several others were seen. The species undoubtedly occurs elsewhere in both districts, especially in Purig, but there was no time to search for it.

*Prunella rubeculoides muraria* Mein

Occurred sparingly in Zaskar from Lagong to Shakkar below Rangdum. A female in first plumage was taken at Lagong.

*Cinclus cinclus cashmirensis* Gould

A pair was seen at Lagong on July 11, 1933.

*Cinclus pallasii tenuirostris* Bp

A specimen was taken at Bok on September 13, 1931.

*Delichon urbica* (L)

Generally distributed from Kargiak to Kargil in July, 1933. In September, 1931, it was present until the 15th.

*Riparia rupestris* (Scop)

Distributed much as is the last species. In 1931 specimens were collected at Reru on September 18.

*Apus apus* (L)

A flock of twelve was flying about Seni on July 21, 1933. In Purig swifts were common, especially in the lower part of the valley.

*Apus pacificus* (Lath)

A single white-rumped bird that was probably of this species occurred with the preceding species at Seni.

*Upupa epops epops* L.

In 1931 specimens were taken at Reru and Cha in September. In 1933 the species was first observed at Sangu, where one was collected; several others were seen. They occurred then down the valley at the large villages.

*Coracias garrulus semenowi* L & T

On September 11, 1931, I found a dead bird, dry but with feathers intact, at Rangdum. Stragglers probably occasionally enter the area.

*Cuculus canorus* L

Observed only at Yuljuk, where an adult male was taken on July 26, 1933. Cuckoos occur up to Leh, where I have taken specimens of the race *telephonus*, they are probably of regular occurrence in Purig. The Yuljuk specimen, compared with the type of *bakeri*, shows well the characters on which the form is based.

*Falco peregrinus* L

A duck hawk was seen around the Phuktal monastery near Cha in September, 1931. The monks said a pair stayed there and ate pigeons.

*Falco tinnunculus* L

Apparently generally but sparsely distributed in Zaskar. In 1933 it was seen at Kargiak, Cha, Mune, and Seni.

*Accipiter nisus melanoschistos* Hume

A female was seen at Yuljuk and another at Guntung in 1933. I make subspecific identification from a pair taken at Nimu, Ladakh, with a nestling, on August 3 and 4. The Yuljuk bird had prey and permitted close approach.

*Circus aeruginosus aeruginosus* (L)

A specimen was taken at Cha in September, 1931, and later another was seen. One was taken at Hamling on September 16, 1931.

*Gypaetus barbatus* (L)

A specimen was seen at close range at Kargiak on July 11, 1933. Its underparts were nearly white. The species is common in Lahul, but was not elsewhere observed across the Great Range.

*Gyps himalayensis* Hume

A griffon was seen at Tetha on July 15, 1933. No others were observed.

*Anas acuta* L

A flock of five were seen on a small pond near Rangdum on September 12, 1931.

*Mergus merganser* L

In 1933 two were seen at Hamling on July 21, and one was observed at Rangdum on July 24

*Columba livia neglecta* Hume

A small flock was seen at Mune on July 18, 1933 In Purig it is common Specimens were collected at Tsaliko

*Columba rupestris turkestanica* But

This is the common pigeon of the Zankskar, it was found about all settlements It becomes scarcer below Tangola Birds in first plumage were numerous in July, 1933 A Kargiak bird had its crop filled with a round soft madder-colored insect larva, about half as large as a pea, which an old man said it had found in the sand

*Columba leuconota leuconota* Vigors

The snow pigeon is not rare between Kargiak and Lagong, where specimens were taken in 1931 and 1933 In 1933 five were seen at Rangdum and a similar number at Tangola At Tangola all three species of *Columba* occurred together These birds are less a species of the settlements than the others, and they appear to be rare In Lahul they are said to descend from the hillsides in seeding time in flocks of hundreds

*Streptopelia orientalis meena* (Sykes)

A stray male was taken at Abring on July 22, 1933. No others were seen till we reached Guntung, where they were not uncommon and where one was collected

*Charadrius mongolus atrifrons* Wagl.

Plovers with young in down or half fledged were common around Padum on July 19, 1933 A few were seen at Abring also In September none were observed in the district.

*Calidris minuta* (Leisler)

A male was taken at Rangdum on September 11, 1931.

*Calidris temminckii* (Leisler)

Specimens were taken at Rangdum on September 11, at Bok on

September 14, and at Kargiak on September 29, 1931. It is probably a not uncommon migrant.

*Tringa totanus eurhinus* Oberh

The redshank breeds in the marshes about Rangdum and is not uncommon. Individuals were taken there in breeding dress on July 24, 1933, and in fall dress on September 11, 1931.

*Tringa nebularia* (Gunn)

A specimen was seen on the spring pond at Seni with other sandpipers on July 20, 1933.

*Tringa glareola* L

A few were seen at Seni, and one was taken in Purig above Parkachen.

*Tringa ochropus* L

There were stray specimens about Rangdum and at Kargiak in September, 1931. In July, 1933, there were two at Seni, one of several seen at Rangdum was collected.

*Tringa hypoleucos* L

Seen in 1933 at Hamling, Seni, and Yuljuk, but not collected. At the latter place there were six in a flock.

*Ibidorhyncha struthersii* Vigors

An individual was seen at Seni and another at Hamling. At Yuljuk there were three, of which one was collected. At Sangu the natives said they were not rare.

*Sterna hirundo tibetana* Saunders

A specimen was collected at Seni on the spring pond on July 19, 1933, and the next day five more were seen.

*Tetraogallus himalayensis himalayensis* Gray

Snow cocks were common at Kargiak near Ichor and at Hamling in 1933. In 1931 they were seen above Rangdum and behind Sarle.

*Alectoris graeca pallescens* Hume

Chikor were common at Sarle and Cha in September, 1931. Some were only half grown. In 1933 they were seen only at Tetha, where one of about a dozen was collected. They are found in Purig also.

## APPENDIX A

ADDITIONS TO THE AVIFAUNAL LIST OF LADAKH AND RUPSHU AS GIVEN  
BY COLONEL R. MEINERTZHAGEN<sup>4</sup> AND B. B. OSMASTON,<sup>5</sup>  
AND NOTES ON SOME OTHER LITTLE-KNOWN SPECIES

I visited the district of West Tibet in the summers of 1931 and 1933. In 1931 Bara Latza was crossed on June 20, and the route to Tso Kar, Pologonka, Puga, Tso Morari, Tso Kyun, and Hanle was followed to Nima Mud on the Indus. Then the way went across Tsaka La to Shushal, along Pangong Tso to Trangse, and across Chang La to Leh. From Leh my route led to Lamayuru and up the Kangri Nulla to Kangri La and over to Rangdum in Zaskar. The Zaskar road led to Shingkun La, which was crossed on October 2. In 1933 the itinerary began at Shingkun La on July 10 and continued across Pensai La and the Rangdum River to Kargil. The rest of the journey included Likir, Leh, Tok, Hemis, Gya, Tso Kar, and Bara Latza, the last of which I crossed on August 25.

Specimens collected during the 1931 trip have been dispersed, and I am making use, for the most part, of notebook data. Those collected in 1933 are preserved in the Museum of Zoology, University of Michigan, Ann Arbor, Michigan.

*Erythrura rubicilla severtzovi* Sharpe*Erythrura rubicilloides lapersonnei* Mein

An adult male of each species was taken at Puga on July 5, 1931. Eggs of the former were found in the *drama* bushes. Both forms are known from Ladakh, but they have not been commonly taken at the same place during the breeding season.

*Montifringilla blanfordi* Hume

A juvenile and an adult male were taken at Tso Kyun, Rupshu, on July 11, 1931, and adults near Kiangchu (More Plain) a few days

<sup>4</sup> Meinertzhagen, R., "Systematic Results of Birds Collected at High Altitudes in Ladakh and Sikkim," *Ibis*, Ser. 12, 3, 363-422, 571-633, 1927.

<sup>5</sup> Osmaston, as cited in note 3.



earlier On August 21, 1933, a pair of adults and a young one in first plumage were taken at Kiangchu at the same place where the species was found in 1931

*Emberiza icterica* Eversm

An adult in fall plumage was taken at Kiangchu on August 20, 1933 A specimen was taken in Zankskar in 1931

*Melanocorypha maxima* Gould

This species was not uncommon in the wet meadow before Hanle, where there were nests with fresh eggs on July 13, 1931, and where several birds were collected It had not previously been known to breed in the Indian Empire

*Phylloscopus inornatus humi* Brooks

An adult male was taken at Cha, Zankskar, on September 25, 1931

*Cephalopyrus flammiceps flammiceps* (Burton)

There was a flock at the mouth of the Kangi Nulla in September, 1931 One was shot, but the skin was lost

*Luscinia svecica pallidogularis* (Zarud )

A juvenile specimen in full first plumage was taken at Sakti on August 2, 1931 It is much different in coloration from the usual *abbotti* that occurs throughout Ladakh

*Coracias garrulus semenowi* L & T.

A male was collected at Spitok on August 19, 1931 A carcass was found at Rangdum in 1931

*Alceco atthis* (L )

A specimen was seen near Hanle on July 12, 1931 Osmaston records seeing one above Leh.

*Cuculus canorus telephonus* Heine

A juvenile in hepatic plumage was taken at Spitok on August 15, 1931, and an adult male at She on August 9, 1933.

*Clamator jacobinus* Bodd

A male was collected at She on August 9, 1933

*Circus aeruginosus aeruginosus* (L)

A female was taken in Zankskar in September, 1931, also at Tso Kar on August 18, 1933 Babault (*Miss Bab Prov. Cent de l'I Rég Him*, 1920) records a specimen from Tso Morari.

*Falco tinnunculus dorriest* Swann

A pale female with wing measurement of 277 mm was taken at Spitok on August 24, 1931.

*Athene noctua* (Scop)

One was seen on the dry hills near Tok on August 25, 1931, and another at Kiangchu on August 21, 1933

*Streptopelia decaocto decaocto* Friv

A specimen was collected at She in August, 1931

*Oenopopelia tranquebarica tranquebarica* (Herm)

A female was taken at Nimu on August 4, 1933

*Coturnix coturnix* (L)

A specimen was seen at Puga on July 5, 1931

*Larus ridibundus ridibundus* L

A female was taken at Spitok on August 22, 1931

*Charadrius leschenaulti* Less.

A pair was seen near Kiangchu, Rupshu, on June 25, 1931 A female, with bare belly patch and feigning lameness, was taken at Tso Kyun on July 11, 1931 A fall-plumaged male was collected at Spitok on August 21, 1931, and another on August 5, 1933 I believe the species breeds regularly in Rupshu

*Charadrius dominica fulva* (Gm)

A specimen was collected from a flock of twenty along the Indus near She in August, 1931.

*Terekia cinerea* (Güld )

I shot a female at Spitok on August 24, 1931

*Tringa nebularia* (Gunn )

A female was collected at Spitok on August 22, 1931

*Calidris testacea* (Pall )

Two males in full breeding plumage were collected on Tsakzhun Tso on July 22, 1931

*Calidris minuta* (Leis )

Two males were taken at Spitok on August 4 and 5, 1933

*Capella stenura* (Bp )

A specimen was taken at Tso Kar on August 18, 1931 This species has been recorded by Sharpe from Leh

*Himantopus himantopus* (L )

Two were seen at Tso Kar on August 18, 1933

*Ibidorhyncha struthersii* Vigors

This was common on the Indus between Spitok and She in August, 1931 It is not rare in Zankskar and Purig, where its occurrence has been recorded by Osmaston

*Numenius phaeopus* (L )

A bird alighted on the plain beside the Indus at Spitok on August 21, 1931, and stayed there all day It was very shy

*Numenius arquata* (L )

A specimen was seen on the plain beside the Indus at Spitok on August 21, 1931

*Chlidonias leucopareia indica* (Steph )

A specimen was taken along the Indus near Spitok in August, 1931

*Fulica atra* L.

A lone bird was seen on the Tso Kyun on July 12, 1931

APPENDIX B

ADDITIONS TO LIST OF KULU BIRDS AS GIVEN BY HUGH WHISTLER,<sup>6</sup>  
AND ADDITIONAL NOTES ON OTHER SPECIES WHOSE STATUS IS  
UNCERTAIN

*Parus major planorum* Hart

Whistler reports *caschmirensis* from Kulu, but my specimens from this district have smaller wing measurements: 9 males, 68-72 mm, 10 females, 63-70 mm. In other characters, too, they agree with Hartert's type. This form, which breeds in the lower foothills, was named from winter migrants and is smaller than *caschmirensis* of the high mountains.

*Parus monticolus monticolus* Vigors

This was a not uncommon species about Naggar.

*Sylviparus modestus simlaensis* Stuart Baker

Not common, but I took specimens at Shedupattar in October, 1930.

*Trochalopteron erythrocephalum erythrocephalum* (Vigors)

Common in winter in the thickets along the Beas near Kulu and also at Arsu and Bajaura.

*Pomatorhinus erythrogenys* Vigors

Though I have not taken the species in Kulu, on two occasions I saw specimens there, on the Chunagai Pass before Rampur City and farther beyond at Arsu.

*Leioptila capistrata pallida* Hart

The species is rather common about Banjar, where specimens were taken in November, 1931, and January, 1933.

*Turdoides terricolor sindeanus* Ticeh

These birds are common in the dry stretch below Luri Bridge, where specimens were taken on December 8, 1931.

<sup>6</sup> Whistler, Hugh, "A Note on the Birds of Kulu," *Journ. Bombay Nat. Hist. Soc.*, 31: 458-485, 1927.

*Fulvetta vinacea kangrae* T & W

Found locally in small flocks in winter at altitudes of about 5,000 feet Four were taken at Banjar in December, 1932, and January, 1933

*Molpastes cafer intermedius* (Jerdon)

The species is not rare in Seraj, and it occurs at Kulu also I have taken specimens at Kulu, Bhuin, Larji, and Arsu, from November to June

*Pteruthius xanthochloris occidentalis* Harington

Two males were taken on November 26, 1933, on Bushreo Pass, and other specimens were collected in the district in 1931 The species is not common, but in the winter a few can usually be found with every large tit flock

*Pteruthius erythropterus* (Vigors)

A female was taken at Kulu, December 26, 1933

*Certhia familiaris hodgsoni* Brooks

I have never found it common, but at least one specimen was taken above Naggar at 9,000 feet, in 1930, and one at Arsu on November 18, 1933

*Saxicola torquata przewalskii* (Pleske)

Found not rarely around Kulu in December of 1932 and 1933 Wing measurements, 8 males, 74-78 mm

*Phoenicurus erythronotus* (Evermann)

In January, 1933, the species was rather common along the river at Kulu, and several were collected.

*Phoenicurus erythrogaster grandis* (Gould)

A pair was taken at Kulu in January, 1933.

*Tarsiger chrysaeus whistleri* Ticeh

This species is a not uncommon winter resident along the Beas I have also taken birds in winter at Arsu and Banjar. Most of the specimens were in immature plumage.

*Saxicoloides fulcata munda* Van Tyne & Koelz

Whistler doubted that the species occurs in the district, but it is not rare in a little stretch below Luri Bridge. Specimens were taken there on December 8, 1931

*Turdus boulboul* (Latham)

A male was taken at Kulu on January 9, 1933

*Turdus albocinctus* Royle

This is a locally common bird, but it usually stays above 6,000 feet. Specimens were taken in Shim Nulla and Naggar Nulla

*Turdus rubrocanus rubrocanus* Gray

A large flock was seen above Bathad on November 7, 1930, and specimens were collected

*Oreocincla mollissima simlaensis* Stuart Baker

In winter this is a not uncommon bird along the Beas. Babault took a male, but did not give the subspecies

*Oreocincla dauma dauma* (Latham)

A male was collected at Kulu on January 10, 1933. Whistler gives a sight record

*Prunella strophata jerdoni* (Brooks)

Not common. Specimens were taken at Banjar in December, 1932, and January, 1933, at Arsu in November, 1933

*Prunella atrogularis butoni* (H & M)

Rather common in winter. Specimens were taken at Arsu in November, 1933, and at Kulu in January and December of that year

*Zoothera monticola* Vigors

A male was taken at Naggar on January 14, 1931. A specimen was seen above Bathad on November 29, 1933

*Muscicapa strophata strophata* Hodgson

Seen occasionally in winter along the Beas and the Tirthan. I found them breeding above Halan in May, 1931.

*Muscicapa ruficauda* Swainson

A male was taken in Shim Nulla in May, 1931.

*Muscicapula tricolor notata* (Whistler)

Specimens were taken in the rhododendrons above Zana, at 10,000 feet, in May, 1931

*Chelidorhynch hypoxanthum* (Blyth)

Not uncommon, singly or in pairs, at Kulu during the winter. Specimens were taken in December, 1932, 1933, and in January, 1933

*Niltava sundara whistleri* Ticeh

Four specimens were taken at Kulu in December, 1933

*Lanius schach tephronotus* (Vigors)

A male was taken at Kulu, December 26, 1932, wing measurement, 98 mm, a female was collected there on the same date, 1933, wing measurement, 95 mm

*Orthotomus sutorius guzurata* (Latham)

Whistler records hearing the species once at Kulu. I saw three specimens there on December 12, 1933, and collected one

*Phylloscopus affinis* (Tick)

A few birds breed in the juniper scrub on the peaks above Katrain. I collected a male there on May 8, 1931

*Phylloscopus collybitus tristis* Blyth

Occurs sparingly on the dry hillsides in Kulu and Seraj during the winter. Found rather more common than usual at Arsu in November, 1933. A pair was collected at Kulu on January 10, 1933. In ten Kulu specimens the second primary is between 7 and 8 or equal to 8, and in three specimens between 8 and 9. Whistler gives sight records

*Phylloscopus reguloides kashmiriensis* Ticeh

A breeding male was taken in Zana Nulla on May 25, 1931.

*Horeutes brunneifrons whistleri* Ticeh

Single males were taken above Katrain, at 11,000 feet, on May 8, 1931, and at Arsu on November 16, 1933

*Franklinia gracilis gracilis* (Franklin)

Three males were taken at Arsu in November, 1933

*Cephalopyrus flammiceps flammiceps* (Burton)

Specimens were taken at Naggar and above Katrain in May, 1931.

*Regulus regulus himalayanus* Jerdon

In summer this species was always found at about 9,000 feet above Naggar. In the winter of 1931 it was common at Banjar at 5,000 feet.

*Pyrhula aurantiaca* Gould

Two males were taken at Banjar on January 3, 1933

*Procarduelis nipalensis nipalensis* (Hodgson)

An adult male and immature birds were taken above Naggar, 9,000 feet, in October, 1930

*Callacanthus burtoni* (Gould)

Numbers fed on the deodar seeds around Naggar in January, 1932. I have seen the species elsewhere only at Tarlognath, Chamba, where nestlings were taken in August, 1930

*Emberiza cia par* Hart

This form is not uncommon in the fall and winter. Specimens were collected in the districts of Kulu and Seraj in 1931, 1932, and 1933

*Emberiza fucata* subsp ?

A female was taken at Arsu on November 20, 1933. Its wing measures 56 mm., which is much smaller than measurements given in Baker's *Fauna of British India*.

*Anthus hodgsoni hodgsoni* Richmond

A breeding male was taken May 8, 1931, at about 11,000 feet in Shim Nulla



*Anthus spinoletta couellii* Sav

Flocks occur in winter along the Beas and in Seraj, chiefly on the rice fields, but also on the dry hills. I have seven specimens taken in December, 1932, and November, 1933.

*Lalage melaschista melaschista* (Hodgson)

I have found the species only at Katrain, where I collected specimens in 1931.

*Aethopyga gouldiae gouldiae* (Vigors)

Seen in the *nulla* above Naggar in April, 1931, feeding on flowers of *Rhododendron arboreum* and collected in Shim Nulla at 7,000 feet on May 5, 1931.

*Dicaeum ignipectus ignipectus* (Hodgson)

Whistler records two sight identifications of this species. It was common around Kulu in the mistletoe in December, 1932, and at Banjar in January, 1933. It was not common in Kulu in December, 1933.

*Picus canus sanguiniceps* Stuart Baker

Not common, but I have a few specimens. Naggar, May 6, 1931, Kulu, December 27, 1933.

*Dryobates hyperythrus marshalli* Hart

Found commonly above Naggar at Shedupattar near the tree limit in October, 1930 and 1931.

*Vireo innominata simlaensis* Ticeh

This is a not uncommon winter bird along the Beas near Kulu. I have also taken specimens at Banjar and Arsu in winter.

*Cyanops asiatica asiatica* (Latham)

A female was taken at Kulu on December 21, 1932.

*Taccocua leschenaultii srirkee* (Gray)

A male was taken at Luri on December 7, 1931.

*Bubo bengalensis* Franklin

Whistler reports sight records. On June 7, 1930, a nestling that appears to be of this species was collected above Naggar.

The great owl *B turcomanus* occurs in the district above the tree limit on the Lahul and Spiti borders

*Glaucidium brodiei* (Burton)

I found the species not rare at Zana, altitude 8,000 feet, on January 25, 1932. Singing specimens were heard at Saharan on November 26, 1933, and on the other side of the Bushreo Pass two days later. Specimens taken in Rampur-Bushahr are of the race *brodiei*.

*Aquila nipalensis nipalensis* (Hodgson)

Two that were feeding on a trout were shot near Manglor in December, 1930.

*Hieraeetus pennatus* (Gm.)

Whistler quotes Donald, but records no specimens. A male was taken at Naggar on April 15, 1931.

*Buteo buteo burmanicus* Hume

On October 23, 1930, a male was taken at 9,000 feet above Naggar. On January 24, 1932, three males and a female were collected at Katrain. Wing measurements, males, 381-417 mm, female, 417 mm.

*Buteo rufinus rufinus* (Cretzsch.)

A pale bird, a female, such as is common on the Punjab plains in winter, was taken at Arsu on November 15, 1933. Other such specimens have been seen in Kulu in winter, but the common form of this species wintering there is much darker than the bird of the plains. Examples, nearly alike in coloration, were taken: male, Katrain, January 24, 1932; female, Arsu, November 21, 1933, male, Kulu, December 24, 1933, female, Kulu, December 27, 1933.

*Falco peregrinus peregrinator* Sundevall

Seen by Whistler. An adult male was taken at Naggar on January 5, 1931.

*Columba livia livia* Gm.

*Columba livia neglecta* Hume

Whistler lists no subspecies, but it appears that the common form is *neglecta*. On December 27, 1933, a lone female was collected that

has a clear white rump and paler upper parts, and seems, therefore, referable to typical *luna*.

*Arboricola torqueola millardi* (Stuart Baker)

I collected a specimen above Naggar at 9,000 feet, in October, 1930

*Butorides striatus* (L.)

I saw a bird of this species at close range a little above Kulu on June 5, 1931. I had no gun and hence could not collect it.

*Anas acuta acuta* L.

A specimen was taken on the Beas near Katrain in April, 1931

UNIVERSITY OF MICHIGAN

## NOTES ON THE WINTER BIRDS OF THE LOWER PUNJAB

WALTER KOELZ

THE notes here presented apply chiefly to the District of Hissar around Sirsa. There are fewer data from around Lahore. I made collections in both places during the winter of 1931, but most of these have been dispersed and are not available to me for study. In 1933 I spent from January 19 to February 9 and from February 23 to March 22 around Sirsa, and the time between these two periods at Lahore, where I collected within the six miles between Shalamar Gardens and the Ravi River. In the District of Hissar I spent most of the time at the city of Sirsa and at a little artificial lake called Parwali, some eight miles away. I made an expedition of a few days to Darba, toward the Bikaner border, and sent a native collector toward Karnauli. The Hissar collections cover roughly, then, an area within a radius of twenty miles of Sirsa.

The terrain around Lahore and Sirsa is flat. Most of the land is cultivated and in winter, in places where enough water is available for irrigation, winter crops, chiefly mustard, wheat, and barley, are grown. In dry fields Cicer (*channa*) is the winter crop. Among the fields are scattered trees of *Acacia* and *Zizyphus*. Numerous plantings of these and other shade trees are found along roads. There occur near the cities a few orchards that grow *bher* (*Zizyphus*), pomegranates, and oranges, at Lahore mangos are planted. Near it there may be seen a large forest of small *Dalbergia* trees, a grove of *Eucalyptus*, and a "jungle" of grass (*sarkhana*?) along the Ravi. The banks of the Ravi near by are barren and sandy, but a reedy oxbow loop is frequented by many kinds of water birds.

Parwali Lake is an open reservoir, not over one and one-half miles in circumference, that was not over three feet deep anywhere at the beginning of our visit, in late March it was nearly dry. The still water in the canals that run down to Ortu teems with fish. The country surrounding the lake is sparsely cultivated, and large

tracts are occupied by clumps of scrubby bushes. The Darba country is unirrigated and, because of several years of drought, was almost desert. In many places there are moving dunes, and only toward the Bikaner border does one find any ground cover.

The other major differentiated habitats are not apparent to the superficial observer. Owing to peculiar soil conditions certain plants grow only in regions where the summer rains make the waste fruitful, weed seeds, which are scattered there by the elements, form the winter food of many birds. For this reason one finds such birds as *Melanocorypha bimaculata*, *Columba oenas*, and *Pterocles orientalis* restricted to small parts of a large area that is apparently uniform in physical aspects.

The climate in winter is generally cool and pleasant. The nights are cold, and sometimes ice forms in the water basin. The days are not hot, and often one can wear a coat all day. After the first of March the heat begins to grow, and the snakes and insects come forth. There is then a stronger movement in the wintering bird population.

In the cold months the bird population of these areas is composed of a mixture of winter visitors from the northerly regions and of permanent residents. Considerable movement, especially noticeable on Parwali Lake, takes place from day to day. Species come and go, or flocks of a species pass over after a short rest. On the plains a given area may be frequented today by species that before had been found only a mile away, and so on.

Thanks to a plentiful supply of ground squirrels, hares, small birds, and fish, birds of prey are particularly common in the area.

Several naturalists have been very helpful to me during the preparation of this manuscript. Dr C. B. Ticehurst has advised me on certain matters pertaining to nomenclature, and Mr James Peters, Dr Ernst Mayr, Dr Josselyn Van Tyne, and Mr Pierce Brodkorb have given generously of their time in comparing certain specimens with material in the collections under their care. I gratefully acknowledge my obligation to them.

#### LIST OF SPECIES

*Corvus corax laurencei* Hume

Not uncommon around the city of Sirsa, where refuse provided plenty of food. They occurred in the open country also. At Parwali

a pair came on March 7, 1933, to the bird carcasses around camp, and the cheels (*Milvus*) tried to chase them away. A raven slyly sidled up to a cheel and savagely plucked a primary. The cheel fell on its back in an attitude of defense. The raven repeated his attack on another cheel, and his enemy withdrew.

*Corvus splendens zugmayeri* Laubm

Generally abundant. At Lahore in the winters of 1931 and 1933 there regularly occurred the roosting flight of crows that has been frequently described. About 5.45 P.M., from three northerly and three southerly directions, birds would begin flying in a line toward the forest, they continued till dusk. If five crows per second passed a given point and the flight lasted twenty minutes, 6,000 crows passed in each line. Three such lines were visible from camp, and three others entered from the opposite side of the woods. Scattered remains on the ground in the woods showed that the owls knew about the assemblage. At Sirsa the crows came to feed on the bird carcasses around camp by sunrise, and by 8 A.M. all had gone, leaving the remains of the food till night.

*Dendrocitta vagabunda pallida* (Blyth)

Occasionally seen at Lahore, where three specimens were taken on February 12 and 16, 1933.

*Parus major planorum* Hart

Not rare in the groves and tree rows at Lahore. The race *caschmirensis* is usually recorded from Punjab, but my specimens (wing measurements, 67-72 mm.) are too small for this form, they agree with Hartert's type in all characters.

*Turdoides terricolor indianus* Ticeh

Occurred commonly in flocks, usually in the orchards. Wing measurements, 6 specimens, 104-111 mm.

*Argya earli* (Blyth)

Taken only at Lahore, where flocks numbering as many as twenty-five birds occurred in the Shisham jungle and in the rushes about the oxbow. Wing measurements, 10 males, 90-95, 6 females, 88.5-92 mm.

*Argya caudata caudata* (Dum )

Common and generally distributed in both districts, especially in the bushy stretches Wing measurements, 16 males, 77-83 mm , 13 females, 75 5-80 5 mm

*Argya malcolmi* (Sykes)

Taken only at Sirsa Wing measurements, 6 specimens, 113-119 5 mm

*Chrysomma sinensis hypoleuca* (Franklin)

Found only at Lahore, where it was common in the grain fields near Shalamar Gardens Wing measurements, 10 specimens, (60) 65-68 mm

*Molpastes cafer pallidus* Baker

Occurred with the preceding species, but less common Wing measurements, 6 males, 94-98 5 mm , 3 females, 90-95 mm

*Molpastes leucotis leucotis* (Gould)

Very common and generally distributed, at both Lahore and Sirsa Flocks feed heavily on fruit Wing measurements, 9 males, 80-89 mm

*Certhia himalayana limes* Mein

A few creepers in the mango gardens and Eucalyptus grove at Lahore Specimens were collected on February 13 and 17, 1933

*Saxicola caprata bicolor* Sykes

A common bird, usually found in the cultivated fields Wing measurements, 8 males, 70-73 mm.; 8 females, 66-70 mm.

*Saxicola torquata maura* (Pall )

Not uncommon in or at the edge of cultivation at Sirsa and Lahore, occurred singly or in pairs Wing measurements, 5 males, 69-72 mm ; 13 females, 63-70 5 mm

*Oenanthe picala* (Blyth)

Generally distributed like the last species, but much less common.

*Oenanthe capistrata* (Gould)

The only records are a male taken at Sirsa on January 29 and two females collected on January 25 and February 1, 1933

*Oenanthe opistholecua* (Strickl )

Rather rare and seen only on the Sirsa plains Wing measurements, 5 males, 89-94 mm , female, 91 mm

*Oenanthe isabellina* (Cretzsch )

Distributed like *O d albifrons* and just about as common Wing measurements, 4 males, 94-99 mm , 2 females, 94 and 95 mm

*Oenanthe deserti atrogularis* (Blyth)

Common and generally distributed on the bare fields and plains of both districts Wing measurements, 9 males, 89-98 mm , 11 females, 86 5-92 5 mm

*Oenanthe xanthoprymna chrysopygia* (De Fil )

Found only in 1931, near the Bikaner border on the dunes One specimen was collected and others were seen

*Cercomela fusca* (Blyth)

Seen once at Lahore, beside the Shalamar Gardens wall, and at Sirsa along with *Emberiza s striolata* It was not uncommon at Sirsa Wing measurements, 2 males, 88 5 and 89 5, 3 females, 85-87 mm

*Phoenicurus ochrurus phoenicurioides* (Moore)

Common and widely distributed in both districts It frequented thick brush and also occurred at times with species of *Oenanthe* on the plains Wing measurements, 8 males, 81 5-83 mm ; 3 females, 79 5-82 mm The wing measurements of my Sind and Punjab specimens are much smaller than those of breeding hill birds of the Punjab and Ladakh.

*Luscinia svecica pallidogularis* (Zarudny)

Common in both areas, occurred among the irrigated crops, in the reeds, and also in thickets. Molt was nearly completed on specimens taken in March Wing measurements, 17 males, 69-75 mm ; 7 females, 68-70 (73) mm



*Saxicoloides fulcata cambaiensis* (Lath )

Generally distributed and fairly common in both areas Wing measurements, 7 males, 72-76 (78) mm , 4 females, 71-74 mm

*Copsychus saularis saularis* L

Rare The only records are of two males taken at Parwali on January 22 and 25, 1933

*Turdus atrogularis* Temm

Not uncommon at Lahore in the Eucalyptus grove, but only one was seen at Sirsa, a male taken on January 30, 1933

*Muscicapa parva parva* (Bechst )

Wintered sparingly at Sirsa in the cemetery grove and in orchards where there was a pool At Lahore also it occurred in the latter sort of habitat Wing measurements, 10 males, 65-71 mm , 3 females, 66-67 mm

*Leucocirca aureola aureola* (Leas )

Occurred in small numbers at Lahore and Sirsa, usually in the orchards Elsewhere there was seldom to be found the dense foliage that these birds seem to like to dive about in Wing measurements, 9 males, 82-85 mm , 3 females, 76 5-82 mm

*Lanius excubitor lahtora* (Sykes)

Common at Lahore and in the Sirsa district, usually on the open plain, where occasional trees or shrubs offer a perch Wing measurements, 14 specimens, 111-116 mm One of the specimens is like the race *pallidirostris* in the amount of black on the secondaries

*Lanius vittatus* Valenc

First specimen taken at Sirsa on January 28, 1933. From then until the end of February it was not observed It was not uncommon in March One was taken at Lahore on February 18

*Lanius schach erythronotus* (Vigors)

Occasional specimens taken at Sirsa during all our stay Wing measurements, 2 males, 89 and 90 mm , 5 females, 88-96 mm On two of the males the white spot at the base of the primaries is very faint.

*Lanius cristatus isabellinus* H & E

A common bird of the uncultivated areas

*Tephrodornis pondicerianus pondicerianus* (Gm )

Fairly common, usually in pairs or small parties in scattered trees or groves at Lahore At Sirsa the species was rare, and the only two specimens, a pair taken on February 5, 1933, are of the *freta* race (wing measurements, 90 and 88 mm ) Wing measurements, 3 males, 89-91, female, 83.5

*Pericrocotus brevirostris brevirostris* (Vigors)

Common at Lahore in February, 1933 At Sirsa a flock of about ten birds in female dress was seen on February 8 Wing measurements, 6 specimens, 92-94 mm

*Pericrocotus cinnamomeus iredalei* S B

Rather common at Lahore in February, 1933 Wing measurements, 5 males, 66.5-72, 6 females, 66.5-70

*Pericrocotus erythropygia* (Jerd )

Three females taken at Parwali on February 4 and 5, 1933 These were the only specimens seen

*Dicrurus macrocerus macrocerus* Vieill

Generally distributed on the plains, usually at least in pairs, often accompanying grazing flocks Wing measurements, 4 specimens, 144-150.5 mm

*Acrocephalus agricola agricola* (Jerd )

Occasionally seen at Sirsa in the grain fields Only one specimen taken, March 10, 1933

*Locustella naevia straminea* Seeb

First observed at Parwali on March 7, 1933, in the grassy border of a dry canal Birds were seen occasionally thereafter, but were flushed with great difficulty Only one was collected

*Orthotomus sutorius guzerata* (Lath.)

Occasional specimens found, chiefly in the gardens, throughout the winter Wing measurements, 6 males, 50-54 mm.; 2 females, 49 and 50 mm

*Luscinola melanopogon mimica* Madar

Seen only at Lahore, in the reeds along the oxbow    Specimens were taken there on February 11 and 16, 1933

*Cisticola juncidis cursitans* (Franklin)

Common around Parwali Lake in the grass and grain fields  
Wing measurements, 9 specimens, 45-53 mm

*Franklinia buchanani* (Blyth)

Common in the scattered scrub of the semidesert plains, at both Sirsa and Lahore    Males were singing    Wing measurements, 14 males, 50-56 mm , 8 females, 47-54 mm

*Laticilla burnesi* (Blyth)

Common in both districts    At Lahore it occurred in the broad stretch of grass clumps along the Ravi, but at Parwali it kept to totally different cover, namely, the short grass clumps and bushes that grew along the dry canals    Wing measurements, 9 specimens, 54-56 mm

*Hippolais rama rama* (Sykes)

Not uncommon in the bushes and acacias at Sirsa    Wing measurements, 8 males, 59-64 mm , 2 females, 59 and 62 mm

*Sylvia hortensis jerdoni* (Blyth)

Rare, observed only at Parwali, where it was found singly in the acacias    Three males were taken on March 6 and 8, 1933

*Sylvia nana nana* (Hemp & Ehr)

Found only at Sirsa, where it was always rare    Three males were taken in January, 1933    This bird was very restless, even shy, and occupied only the barest plains, where there were scattered stunted shrubs

*Sylvia althaea zagrosiensis* Sar.

An adult male taken at Darba on March 15, 1933 (wing measurement, 66 mm ), has a very much smaller bill than typical *althaea* from Ladakh and also much less white on the outer pair of rectrices

*Sylvia curruca blythi* Ticeh. & Whistler

Common and generally distributed at Lahore and in the Sirsa district, occurred in both trees and scattered bushes. Wing measurements, 15 males, 64-67 mm, 3 females, 63-64 mm. Primaries 2 = 6-7, once 7-8.

*Sylvia curruca minula* Hume

Found at Sirsa, usually on the plains with scattered dwarf shrubs such as *Sylvia nana* frequented. Wing measurements, 5 males, 59-62 mm, 4 females, 57-62 mm. Primary 2 = 7-8.

*Phylloscopus collybitus tristis* Blyth

Occurred commonly in small parties or singly at Sirsa and Lahore. Mustard fields were favorite forage grounds, but other crops were visited, and the species was observed in the trees also. Of the numerous specimens obtained about half might be considered *sindianus* if judged by the length of the second primary. In them 2 = 8-9 or 9-10. The coloring is rather more like that of *tristis*.

*Phylloscopus griseolus* Blyth

The first one seen was taken in an acacia tree on March 11, 1933. Thereafter specimens were collected at Darba, on March 14, where it occurred on the semidesert dune-strewn fields, and at Sirsa, on March 19, among the grain fields.

*Phylloscopus subviridis* (Brooks)

Few seen in the acacia trees at Lahore and Sirsa throughout the winter. They became somewhat commoner in March. Wing measurements, 8 males, 52-58 mm, 4 females, 49-52 mm. Primary 2 = 8-9 or 7-8.

*Phylloscopus inornatus humi* (Brooks)

Few occurred regularly at Sirsa and Lahore in the trees. Wing measurements, 6 specimens, 53-58 mm; second primary between 7 and 8 or equals 7.

*Prinia gracilis lepida* Blyth

Common at Parwali and at Lahore in the tall grasses. Wing measurements, 7 males, 42-46 mm, 3 females, 42-44 mm.

*Prinia flaviventris sindiana* Ticeh

Unsexed specimen taken at Lahore on January 26, 1931, along the Ravi. The bird is in poor plumage, and the race can only be guessed at. No others were seen.

*Prinia socialis stewarti* Blyth

Not uncommon at Lahore and Sirsa. Grain fields with hedge borders were favorite haunts. Wing measurements, 8 males, 45-53 mm; 4 females, 45-48 mm.

*Prinia inornata terricolor* Hume

Common in the scrub of the plains and grassy thickets at Lahore and Sirsa. Wing measurements, 7 males, 50-53 mm, 5 females, 47-49.5 mm.

*Pastor roseus* L.

Large flocks seen near the Bikaner border in 1931. In 1933 only a few occurred with the *Sturnus* flocks. Stray specimens were collected at Parwali on February 28 and on March 2, 7, and 8.

*Sturnus vulgaris porphyronotus* Sharpe

Not rare at Lahore, where seven specimens of this race were taken between February 16 and 18, 1933. At Sirsa, only one bird, a female, taken January 29, 1933, was observed. Wing measurements, 126-131 mm.

*Sturnus vulgaris pollardatzskii* Finsch

The common form at both Lahore and Sirsa. Starlings were not common, however, at the latter place. Wing measurements, 14 specimens, 123-133 mm.

*Acridotheres tristis tristis* (L.)

Generally distributed and abundant, especially in the neighborhood of settlements.

*Acridotheres ginginianus* (Lath.)

Fairly common and generally distributed. It usually followed the herds on the plains, but occurred also on roofs in Sirsa.

*Ploceus philippinus philippinus* (L)

Birds in winter plumage not uncommon in the rushy pools beside Shalamar Gardens. Specimens were taken between February 11 and 21, 1933. Wing measurements, 6 specimens, 67.5-70 mm.

*Ploceus benghalensis* (L)

I have found this species only around wet reedy marshes in Sind and at Keshapur, north of Lahore. It was rather common in both localities.

*Uroloncha malabarica* (L)

Generally distributed where grass seeds are available, occurred usually in small flocks. Wing measurements, 19 specimens, 53-56 mm.

*Amandava amandava amandava* (L)

Locally distributed. Flocks occurred at Lahore along a grassy ditch, where they fed and roosted in the grass, and at Parwah. They are often kept as cage birds and are used, I am told, for sport. No males were seen in full plumage. Wing measurements, 13 specimens, 46-49.5 mm.

*Gymnoris xanthorollis transfuga* Hart

First seen on March 2, 1933, when one was collected from a small flock at Ortu. By the middle of the month the species had become common, being seen most often in blossoming trees. Wing measurements, 15 males, 79.5-84.5, female, 77 mm.

*Passer domesticus indicus* Jard & Selby

Generally distributed and abundant.

*Passer pyrrhonotus* Blyth

Found only at Lahore. In 1931 it occurred around a settlement near Shalamar Gardens, but in 1933 it was found only about a mile from there, in a place where a group of acacias grew around a pool. They fed on pampas grass seeds during the day and roosted in the acacias at night. Wing measurements, 11 males, 66-70 mm, 8 females, 64-66 mm.

*Passer hispaniolensis transcaspicus* Tschusi

Occurred in flocks through the winter at and all around Sirsa. They fed on the dry plain and took refuge in the *Zizyphus* bushes. Often flocks of *P. domesticus* occurred in the same place, but I never saw mixed flocks. Wing measurements, 3 males, 80-81 mm, 7 females, 76-82 mm.

*Emberiza stewarti* Blyth

Seen only at Parwali, where specimens were taken on February 6 and 28, and on March 1, 3, and 11, 1933.

*Emberiza cia par* Hart

Occurred in flocks at Lahore and at Parwali, usually in the pampas grass jungle at Lahore. As is often true of subspecies of other Himalayan birds, this form differs sufficiently in voice and habit from *stracheyi*, the common Himalayan race, to compel attention in the field.

*Emberiza striolata striolata* (Licht)

Small numbers on and around the high mound that lies beside Sirsa. The brickyard at Sirsa was another favorite spot. In its habitat *Cercomela fusca* was always to be found.

*Motacilla alba dukhunensis* Sykes*Motacilla alba personata* Gould*Motacilla alba alboides* Hodgson

*Dukhunensis* occurred commonly at Sirsa and Lahore during all our stay. *Personata* was much less common at both places, and *alboides* was rare. Adult specimens of *alboides* were taken at both localities.

*Motacilla maderaspatensis* Gm

Occurred sparingly along the drying canals at Ortu and at Lahore. Wing measurements, 4 males, 96-100 mm, 4 females, 90-91 mm.

*Motacilla flava beema* Sykes

First seen at Sirsa on February 23, 1933, in March it was abundant. Most of the males taken as late as March 19 had not yet completed their molt.

*Motacilla flava thunbergi* Bill

Female taken at Sirsa on March 19, 1933, it appears to belong to this race

*Motacilla flava melanogrisea* (Hom )

Present in small numbers on our arrival at Sirsa, but not till after late February were they common. Occurred also at Lahore. Specimens taken in late February, 1933, had nearly completed their molt

*Motacilla citreola citreola* Pall

*Motacilla citreola calcarata* (Hodgson)

*Motacilla citreola werae* (But )

In early February, 1933, at Parwali Lake flocks of wagtails scattered over the mud at night and made the lake lively with their sharp clear "cleek," like little chickens that had lost their mother. Sometimes they stopped on the sward in front of our camp. After our return to the lake on February 26 no such flocks were seen. On March 22 they were observed coming in huge flocks to roost in a stand of sugar cane at Sirsa. *Werae* was the commonest form seen at Parwali and Sirsa, but at Lahore *citreola* was apparently more abundant. *Calcarata* was not taken around Sirsa, rare at Lahore.

*Anthus trivialis trivialis* (L )

Occurred in the grain fields at both Lahore and Sirsa. It was taken at the latter place only after February 24 and until March 19, 1933.

*Anthus trivialis harringtoni* Witherby

Male taken at Parwali on March 8, 1933; others at Lahore on February 9, 12, and 14

*Anthus pratensis* (L )

Lone female (wing measurement, 83 mm ) taken at Parwali on February 28, 1933. I did not see others.

*Anthus sordidus jerdoni* (Finsch)

Occurred sparingly, usually singly or in pairs, in the grain fields and at their borders. The first specimen seen was taken on February 23, 1933. A very dark bird was collected at Parwali on March 4



*Anthus rufulus rufulus* Vieill

Occurred sparingly at Lahore and Sirsa, and specimens were taken at both places

*Anthus campestris campestris* (L.)

Six specimens from Sirsa, rather yellowish and less gray, which appear to belong to the typical race *campestris*. Wing measurements, female, January 21, 1933, 87 mm, males, January 23, February 23 and March 7 and 17, 1933, 87-93 mm

*Anthus campestris griseus* Nicoll

A very common bird on the dry fields. Usually it occurred in small flocks. Wing measurements, 34 males, 85-96 mm, 16 females, 82-90 mm

*Anthus roseatus* Blyth

Occurred commonly, usually in flocks, around Parwal Lake and at Lahore along weedy pools and the oxbow. Only one of ten collected specimens is a female. Several have the rosy throat of the adult. Wing measurements, 87-90 and 82 mm

*Anthus spinoletta couellii* Sav

Occurred around the lake at Parwal and in the grain fields at Sirsa and Lahore. Flocks of five to eight were most commonly met. Wing measurements, 3 males, 89.5-91.5 mm, 4 females, 82-88.5 mm

*Melanocoryphus bimaculatus bimaculatus* (Menetr.)

Occurred near Sirsa in huge flocks in 1931, but in 1933 the species was scarce. Lone specimens were taken on January 28 and February 23. The bills of these birds are smaller than those of most Sind specimens of my collection.

*Alauda arvensis intermedia* Swinh

Not rare in the grain fields at Lahore, and two pairs were collected. Wing measurements, males, 112 and 114 mm, females, 106 and 108 mm

*Alauda gulula punjaubi* Whistler

Specimen taken at Lahore in the grain fields on February 12, 1933. At Sirsa the species was common in 1931, but was rare in 1933.

*Calandrella brachydactyla longipennis* (Eversm )

Occurred at Lahore in large flocks and at Sirsa on the bare fields They average smaller than Sind specimens and are more buff below Wing measurements, 9 males, 91-94 mm , two females, 88 and 89 mm I think it possible that two races occur in Sind in winter

*Calandrella ruficalis adamsi* (Hume)

Occurred only along the Ravi on the sand and in the adjacent fields Large flocks were often seen there, February 10-22, 1933 Wing measurements, 9 males, 83-88 mm , 8 females, 79-83 mm.

*Galerida cristata chendoola* (Franklin)

Generally distributed and common Small flocks were usually found Males were singing commonly after early February Wing measurements, 19 males, 98.5-106 mm , 13 females, 94-100 mm

*Eremopterix frontalis affinis* (Blyth)

A male and a female collected near Darba on March 15, 1933 Otherwise the species was not observed These two birds have larger and heavier bills than Sind specimens

*Zosterops palpebrosa occidentis* Ticeh

A common bird in the orchards at Lahore and Sirsa They were usually found in small parties

*Cinnyris asiatica* (Lath )

Occurred sparingly during February in the vegetable gardens at Sirsa, feeding on the pea blossoms, and in the orange and other orchards Males had not then begun to molt On March 8, 1933, they were very common in Calotropis, which was coming into full bloom Males were in full or nearly full plumage and were very vocal At Darba, on March 14 and 15, 1933, there were fifteen or twenty in each tree of blossoming Bignonia Collected specimens appear to be intermediate between the forms *asiatica* and *brevirostris* Culmen measurements, 15 males, 14.5-17 mm , 6 females, 14.5-16.5 mm. Wing measurements, males 55-58 mm , females, 52-56 mm

*Piprisoma agile agile* (Tick)

A specimen taken at Sirsa in February, 1931, another on January 25, 1933. Otherwise the species was not observed

*Dryobates mahrattensis blanfordi* (Blyth)

Rather uncommon, but found in both districts in thinly wooded areas or in scattered trees. Wing measurements, 5 males, 100–102 mm, 6 females, 100–104.5 mm

*Brachypternus benghalensis benghalensis* (L)

Most often found in the fruit orchards. At Lahore it was not uncommon, but at Sirsa only two were seen. Wing measurements, 6 males, 139–148 mm, 5 females, 140–150 mm

*Jynx torquilla* L

Records few. Parwali, February 4 and 24, 1933, Lahore, February 17 and 19. The specimens were all taken in the open plain, where scrub bushes and some grass grew together in clumps. The bird taken on February 4 is near the race *torquilla*; the rest are nearer *japonica*

*Xantholaema haemacephala indica* (Lath)

A single bird taken at Sirsa in March, 1931, one at Lahore on February 9, 1933. Otherwise the species was not noted

*Centropus sinensis sinensis* (Steph)

Occurred in both districts. It frequented most commonly the borders of drying canals. I have seen it very abundant in the thick bulrush borders of the lakes at Gurdaspur. I have also met it in the dry scrub far removed from water

*Psittacula krameri borealis* Neum.

Generally distributed and common in both areas. At Lahore the birds went forth from Shalamar Gardens in flocks in the morning and returned to roost in the late afternoon. The vocalization of the flocks, which is always considerable, is sweet or cross by turns. The birds are very fond of *bher*, pomegranates, guavas, and peas, and the growers of such produce must sit beside their crops throughout the day. The parrots become adept at slinking into the orchards, and the watcher probably achieves little by his vigil. Nesting was well begun by March. In mid-February at Lahore birds were busy enlarging holes in the trees. One hole that a *Dryobates mahrattensis blanfordi* had intended to live in and in which he spent his nights had been worked on.

*Coracias benghalensis benghalensis* (L.)

Generally distributed and fairly common in both districts. From about the middle of January pairs became quarrelsome and often were to be seen making a commotion around an old acacia tree that had potential nest holes. One such tree near our camp at Parwali had been preempted by a pair of *Athene brama indica*. A pair of nulkants came singly or together morning and evening and during the day and sometimes stayed two hours at a stretch. Uttering imprecations they rose above the tree fifteen to twenty feet and dropped down at the hole or the owls.

*Merops orientalis orientalis* Lath

Common in both areas. At Sirsa it occurred chiefly in the desert scrub, where small flocks or parties could almost always be found. Wing measurements, 6 males, 91.5–95 mm; 6 females, 90.5–94.5 mm.

*Ceryle rudis leucomelanura* Reichenb

Occurred along the Ravi and in the drying canals at Ortu. At the latter place they had excavated nests in March. Wing measurements, 3 males, 134–138 mm; 4 females, 135.5–141.5 mm.

*Alcedo atthis atthis* (L.)

Occurred at Parwali and along the oxbow loop at Lahore. Wing measurements, 5 males, 72.5–75.5 mm; 5 females, 73–77 mm.

*Halcyon smyrnensis smyrnensis* (L.)

Occurred in small ponds and pools in both districts. Wing measurements, 3 males, 119–122 mm; 4 females, 121–124 mm.

*Tockus brostris* (Scop.)

Two hornbills seen flying over camp at Lahore on February 13, 1933. A female was collected. The other bird was frequently seen around thereafter. The natives said that two pairs regularly remained in the vicinity.

*Upupa epops epops* L

Not rare on the plains at both localities. Wing measurements, 135, 136, 137, 144, 145, 147, 159 mm.

*Apus affinis affinis* (Gray)

A colony of perhaps twenty-five had old nests under a bridge beside Shalamar Gardens on the Amritsar road. They came home to roost toward dusk. Seven specimens collected there on February 22, 1933, had eaten small beetles and flying ants. The species was not seen at Sirsa. Wing measurements, 4 males, 123-134 mm, 3 females, 127-132 mm.

*Caprimulgus mahrattensis* Sykes

A male taken at Sirsa, February 13, 1931, on the desert plain. This is the only record.

*Asio otus otus* (L.)

Common toward Karnauli. Only one was seen at Sirsa. Wing measurements, male, 295 mm, 7 females, 295-309 mm.

*Asio flammeus leucops* (Brehm)

In 1931 a flock of about six stayed in a small patch of scrub near Sirsa. In 1933 none were there, but specimens were obtained in other such places around Sirsa. Specimens were also taken along the Ravi in 1931. On February 26, 1933, a bird of this species tried to catch a bat. Another bat came to the rescue and both pursued the owl.

*Bubo benghalensis* (Franklin)

Only two specimens secured, both at Sirsa, one on February 10, 1931, and the other on February 5, 1933. In 1933 one was frequently seen around the great mound beside Sirsa. It undoubtedly resided in the series of holes that honeycomb this formation. Another was seen at close range in an acacia grove at Ortu on March 1, 1933.

*Bubo coromandus coromandus* (Lath.)

A common species in both districts. Half-grown young were found in nests after mid-January, but the gug gug gug gug of the males could be heard as long as we stayed at Parwali — till March 15. Stomach contents, January 29, 1933, grey titlar, February 1, crow. Wing measurements, 7 males, 391-402 mm; 10 females, 398-423 mm.

*Otus bakkamoena gangeticus* Titch

A male taken in a *bher* tree at Lahore on February 10, 1933 No others were seen

*Athene brama indica* (Franklin)

Common and generally distributed in both areas Around Sirsa almost every suitable acacia tree housed a pair In 1933 there was a pair beside our tent at Parwali At the beginning they spent most of the day sitting outside the hole, but on our approach the male always hastily went inside The female stayed out and on February 5 was shot Next day her place was taken, and on February 28 the second wife was killed On the morning of March 1 her place was taken This bird was killed the next day. All day of March 3 the bereaved mate sat in the hole and from time to time emitted piteous feeble wails. On the 6th wife no 4 had been found, and the normal impatient scolding tone of the husband was resumed All the owls seen all winter were in pairs, where the mates were so readily obtained is not clear. Wing measurements, 4 males, 155-160 mm ; 9 females, 158-166 mm

*Aegyptius monachus* (L)

Rare about Sirsa In 1931 one was killed and two others were seen In 1933 one occasionally came to camp to feed on our carrion When it was there all other vultures made way At Darba on March 16 a mated female was killed The wing measures 727 mm

*Sarcogyps calvus* (Scop)

Not uncommon in both districts, but seldom seen in greater numbers than six The wing of a female from Sirsa measures 593 mm

*Gyps fulvus fulvescens* Hume

Occurred sparingly at both places In my experience this great bird is always rare. One or two, however, are to be seen among every large assembly of vultures. They dominate the smaller species and feed first The ravens, *Neophron*, and crows wait on the outskirts The wing of a male taken at Sirsa measures 655 mm

*Pseudogyps bengalensis* (Gm )

The predominant vulture At Lahore dark-rumped birds were in the majority, and it may be that *G. indicus* was among them. Wings of two adult females from Sirsa measure 554 and 599 mm.

*Neophron percnopterus percnopterus* (L )

Common and generally distributed in both districts. It is the humblest-spirited bird in the region. A flock may always be seen hunting through the piles of dirt and rubbish that the sweeps bring out from the cities. For their chief food the crows are the only important competitors. Specimens taken in adult and immature dress.

*Falco peregrinus babylonicus* Gurney

Only a single bird observed, a male collected at Parwah Lake on March 3, 1933. Wing measurement, 292 mm.

*Falco jugger* Gray

Common, as hawks go, in both districts. One male has a heavily streaked breast. Wing measurements, 7 males, 320-337 mm, 6 females, 356-373 mm.

*Falco chicquera chicquera* Daud

Fairly common in both districts; always in pairs, usually near settlements where there were plenty of small birds. Wing measurements, 4 males, 196-201 mm., 2 females, 224 and 233 mm.

*Falco aesalon insignis* (Clarke)

Only one specimen observed, an adult male killed at Parwah on February 5, 1933. Wing measurement, 204 mm.

*Falco tinnunculus tinnunculus* L.

Rather rare. Only three specimens, all males, were collected. Wing measurements, 238-248 mm.

*Aquila heliaca heliaca* Sav

An immature bird taken at Lahore on January 16, 1931. At Sirsa only two adults, both females, were collected (Jan. 27, 1933, wing spread, 6 feet, 11 inches, Feb 5, 1933, wing spread, 6 feet, 9 inches), but six birds in immature plumage were obtained. The

species was rather rare and was only occasionally seen. It is unmistakable in the field in any plumage. Food, January 27, tibia of small fawn or other grazing animal, February 1, a *Francoelinus*. Wing measurements, 5 males, 562-585 mm ; 3 females, 590-614 mm

*Aquila nipalensis nipalensis* Hodgson

Distributed like the last species but commoner. Wing measurements, 5 males, (505) 533-565 mm , 2 females, 568 and 607 mm

*Aquila rapax vindhiana* Franklin

A common species in both districts. This and the preceding eagles fed regularly on the carrion about camp. The specimens collected show the extremes of light yellow brown and dark brown and many intermediate shades. Wing measurements, 20 males, 457-529 mm , 18 females, 508-546 mm

*Aquila clanga* Pall

Rare. Only two specimens, females, were collected, Parwali, March 5 and 10, 1933. Wing measurements, 517 and 526 mm. At Gurdaspur lakes in 1931 the species was common.

*Hieraaëtus fasciatus fasciatus* (Vieill.)

A male in adult plumage was killed at Sirsa on February 4, 1931; wing measurement, 479 mm. A pair was taken at Parwali on March 10, 1933, both strong buff below with dark shafts, the stripes broader on the upper breast. The wing of the male measures 457 mm , that of the female, 475

*Circus gallicus gallicus* (Gm.)

Not common. Seen only around Parwali, where four specimens were taken. January 28 and March 8, 10, and 20, 1933. The food of two specimens consisted of lizards.

*Butastur teesa* (Franklin)

Common in both areas, and widely distributed. Wing measurements, 4 males, 289-302.5 mm., 3 females, 280, 290, and 310 mm

*Haliaeetus leucoryphus* (Pall.)

Occurred in both districts, but always shy and collected with great difficulty. At Sirsa these birds sometimes came to the carrion



feast provided by our skinning operations. At Parwah and Ortu they were common, and fed heavily on the fish that swarmed in the drying canals, though here, too, they ate from camp at times. The distinctive call was heard daily. Specimens were taken in both adult and immature plumage. Wing measurements, 4 males, 551-592 mm, 5 females, 597-630 mm. There is considerable variation in bill length among the specimens.

*Milvus migrans lineatus* (Gray)

A female taken on March 6, 1933, at Parwah, the only specimen definitely identified. Wing measurement, 511 mm.

*Milvus migrans gorinda* Sykes

Abundant and generally distributed. Flocks visited camp daily for refuse. Some of the birds have conspicuous light-colored heads. Wing measurements, 6 males, 441-485 mm, 2 females, 442 and 482 mm.

*Elanus caeruleus* (Desf.)

Seen only once, at Ortu on March 4, 1933.

*Circus macrourus* (Gm.)

Only rarely seen, but the regions were not particularly suited for harriers. Two males were taken at Parwah on February 6 and 28, 1933. Wing measurements, 330 and 364 mm.

*Circus pygargus* (L.)

An adult male seen on two occasions at Sirsa, on March 21 and 22, 1933. No specimens were collected.

*Circus cyaneus cyaneus* (L.)

Two males in immature plumage taken at Parwah on January 21 and February 5, 1933. Wing measurements, 339 and 341 mm.

*Circus aeruginosus aeruginosus* (L.)

Least rare of the harriers in both districts; always around water. All specimens taken and others seen were in immature plumage. Wing measurements, 2 males, 393 and 401 mm.; 2 females, 409 and 417 mm.

*Buteo rufinus rufinus* (Cretzsch)

Common in both districts, occurred throughout the country, even in the desert, if a perch was available. Most of the specimens collected are pale, and none approach closely the dark birds that winter in the Kulu Valley. Wing measurements, 8 males, 416-439 mm, 11 females, 439-467 mm.

*Buteo buteo burmanicus* Hume

A male (wing measurement, 389 mm) taken at Parwali on March 5, 1933. No others were seen.

*Accipiter badius dussumieri* (Temm)

Not common. Two males were collected at Lahore and a pair at Sirsa. Wing measurements, 3 males, 183-186 mm.; female, 210 mm. These birds are darker than the breeding form in the lower Kangra Valley.

*Pernis apoworus ruficollis* Less

A single bird was seen, a male collected at Parwali on March 4, 1933. Wing measurement, 412 mm. The specimen is darker than any of the eight birds of my collection from the Kangra Valley and from the Sind. Its dark tail bars are the narrowest of the lot and its outer ones the longest. The stomach contained larval bees.

*Columba eversmanni* Bonap

Flocks seen at Parwali and along the Ravi. On February 4, 1933, there were flocks totaling several hundred at Parwali, on March 2 there were flocks of from twenty to fifty. On February 17 a flock of about fifty was seen near Lahore. Wing measurements, 7 males, 195-209 mm, 5 females, 187-203 mm.

*Columba lina neglecta* Hume

Common and generally distributed in both districts. At Sirsa it was found nesting in the wells, which are brick-lined, three feet in diameter and fifty or more feet deep. One pigeon had a nest a foot or two above the water, where a brick had fallen out of the wall.

*Streptopelia chinensis suratensis* (Gm)

The least common representative of the genus, but found in small numbers at both places.

*Streptopelia senegalensis cambaensis* (Gm )

Common and generally distributed in both districts. Usually occurred in small flocks. Wing measurements, 7 males, 123-134 mm, 6 females, 121-127 mm.

*Streptopelia decaocto decaocto* (Friv )

Abundant and generally distributed in both districts. At Parwah at sunrise in early March, 1933, the entire horizon vibrated with the call of the singing birds. On March 4 and 5 four sang in the light of a half-moon till 9.30. Wing measurements, 11 males, 158-173 mm, 7 females, 157-167 mm. A very pale *gugh* was seen among the others at Sirsa on February 25, 1933, but was so shy that we could not shoot it.

*Oenopopelia tranquebarica tranquebarica* (Herm )

In 1931 in early March flocks of this species appeared at Sirsa. In 1933 none were observed.

*Pterocles orientalis orientalis* (L )

Imperial sand grouse or *kashmiri* occurred abundantly on the dry plains toward the Bikaner border. They sometimes came as near as Sirsa. They fed in flocks, usually of about a dozen. At Parwah these flocks came to drink in the early morning. On February 4, 1933, several hundred came, on the 6th, at least a thousand. On March 1 they flew over in flocks of from five to ten, but seldom stopped. On March 14 one was seen at Darba. Wing measurements, 11 males, 227-251 mm, 3 females, 222-230 mm. In the *Memoirs* of Jehangir a game bird is mentioned that can be caught near Delhi in huge numbers by imitating its call. The Kashmiris, he says, are very adept at this imitation. The local name for the bird may be associated with the custom.

*Pterocles senegalensis hindustan* Mein.

Common at Sirsa. In January and February the flocks fed with the imperial grouse toward the Bikaner border, but by mid-March they were around Sirsa. We never saw them drinking at Parwah. A female taken on March 9, 1933, had an egg ready to lay. Wing measurements, 9 males, 171-187 mm; 8 females, 167-173 mm.

*Pavo cristatus* L

Common about Sirsa and all Hindu villages elsewhere. There are none around Mohammedan villages, but at Parwali, a Mohammedan center, they sometimes roosted in trees and were common in the surrounding country, where dense cover afforded shelter. Birds in female dress predominated everywhere. Not more than one bird in twelve could be identified as a male.

*Coturnix coturnix coturnix* (L.)

Generally distributed in both districts, usually flushed from the grain fields in pairs. Wing measurements, 14 males, 102-112 mm; 2 females, 109 mm.

*Francolinus francolinus asiaticus* Bonap

Occurred sparingly in both districts. Around Sirsa it was particularly rare. During March, 1933, a male sang regularly beside our camp at Parwali. He was seen singing in a tree on March 5. Wing measurements, 7 males, 151-159 mm; female, 157 mm.

*Francolinus pondicerianus interpositus* Hart

Common and generally distributed in both districts. It is often kept as a cage bird in the cities. Two were found roosting side by side near dark on February 26, 1933, in an acacia about twelve feet from the ground. Wing measurements, 21 males, 136-152 mm; 21 females, 132-144 mm.

*Grus grus lilfordi* Sharpe

Flocks of *kunj* were to be seen or heard almost daily around Sirsa. On March 5, 1933, at least three hundred alighted on the lake. They came in four flocks and left in small groups next morning before sunrise. Each group followed the next at an interval of about a minute till all were gone. All went toward the west in one direction. In 1931 I witnessed a phenomenal assembly of this species. The flocks gathered from all around until the ground on all sides was blue with birds. At least a thousand must have been assembled. The flocks feed usually on the *channa* pods and doubtless cause considerable loss to the cultivators. Only one specimen, an adult male, was taken in 1933. Wing measurement, 555 mm.

*Grus antigone antigone* L.

Occurred in pairs or flocks up to nine around Parwah Lake. They often came to spend the night on the lake. Occasionally during the night their call resounded, answered invariably by a *Bubo coromandus* that had a nest near by. They always left at dawn. The natives in the Sirsa area have no strong objections to the killing of the species. A young bird taken on January 23, 1933, had the head completely feathered. The head and the upper half of the neck were rusty. Wing measurements, 4 males, 640-660, female, 599 mm.

*Grus leucogeranus* Pall

On March 12, 1933, a hunter brought in an adult male white crane that he had killed near Karnaul, where it had been accompanied by its mate and a huge bird that answered the description of the adjutant which we observed on the same day. The crane had had its leg broken on a previous occasion. I had never before seen the species, and none of the natives questioned knew it. Wing measurement, 626 mm.

*Anthropoides virgo* (L.)

The first demoiselle crane, an adult female, was seen on Parwah Lake on February 26, 1933, and was collected next day in a *channa* field, where it had gone to feed with two bar-headed geese. Only one other bird of the species was seen — an adult male collected on March 3. The natives say that they pass through in great flocks in the fall. Wing measurements, male, 477 mm; female, 480 mm.

*Chlamydotis undulata macqueenii* (Gray)

Not rare in the drier parts around Sirsa. The *channa* fields scattered about in the dry plains are favorite haunts. Wing measurements, male, 402 mm; 6 females, 349-372 mm.

*Choriotis nigriceps* (Vigors)

Three great bustards seen at close range in 1931 at Jorawala, near the Bikaner border. We visited the same region in March, 1933, but found none.

*Burhinus oedinenus indicus* (Salv)

Not uncommon toward Karnaulh A female taken on March 10, 1933, had an egg ready to lay Wing measurements, 3 males, 219-224 mm, 4 females, 213-225 mm Hartert considers Hissar specimens *astutus*

*Cursorius cursor cursor* Lath

Not rare in the dry dune country between Sirsa and the Bikaner border, singly or in flocks up to ten Wing measurements, 13 males, 154-169 mm, 2 females, 158 mm

*Glareola lactea* Temm

Occurred along the Ravi in 1931 On February 27 they were common at Parwahi Lake By March 9 they had all left Wing measurements, 6 males, 150-161 mm, 10 females, 145-156 mm

*Larus genis* Brème

A single specimen collected, it came to Parwahi Lake on March 9, 1933, and was a young male in winter dress, with some of the lesser wing coverts of the juvenile plumage

*Sterna melanogaster* Temm & Lang

Seen commonly at Lahore, but rarely at Sirsa No specimens collected in 1933

*Sterna aurantia* Gray

Generally distributed like the last species One taken at Parwahi on February 4, 1933

*Charadrius alexandrinus alexandrinus* L

Small flocks seen almost daily at Parwahi on the lake. Many of the birds had the rusty crown of adult plumage Wing measurements, 10 males, 108-113 mm.; 8 females, 106-114 mm.

*Charadrius dubius curonicus* Gm

The commoner of the two forms. Seen only at Parwahi, from February 28 to March 10, 1933 Wing measurements, 5 males, 110-124 mm; 4 females, 110-119 mm

*Charadrius dubius jerdoni* (Legge)

A female (wing measurement, 106 mm) taken at Parwali on March 9, 1933, may belong to this race

*Vanellus vanellus* (L)

Occurred along the Ravi in 1931 and in February, 1933. A flock of ten was also seen at Parwali on February 6, 1933. These birds did not come to the mud with the other snipes, but fed on the dry fields bordering the lake. They were very shy, and none were collected in 1933.

*Chettusia gregaria* (Pall)

Not rare around Sirsa in 1931, where flocks of up to twenty birds were seen. They frequented the patches on the meadows that were once wetter than the surrounding land. In 1933 none were seen in these places and only two elsewhere: one at Parwali on February 3 and one at Ortu on March 4. None were collected in 1933.

*Chettusia leucura* (Licht)

Common in the lake at Parwali. Wing measurements, 11 males, 170–181 mm; 3 females, 173–179 mm.

*Lobivanellus indicus aigneri* (Laubm)

Common and generally distributed in both districts. It was regularly heard at night even at Darba, where it seemed that there was not a drop of water. My specimens are much like those of Sind, and I follow Ticehurst in nomenclature. Wing measurements, 6 specimens, 222–226 mm.

*Lobipluvius malabarica* (Bodd)

A single specimen observed, brought in by a collector from Karnauli on March 10, 1933.

*Himantopus himantopus himantopus* (L.)

Occurred commonly on Parwali Lake and on almost all the small ponds around Sirsa. Without exception the birds seen had heavy dusky markings on the head. Wing measurements, 8 males, 236–248 mm; 7 females, 213–227 mm.

*Recurvirostra avosetta avosetta* L

A lone avocet appeared at Parwali Lake on March 1, 1933 It stayed and was captured on the 5th No others were seen

*Limosa limosa* (L)

A godwit that probably was of this species came to Parwali Lake on March 5, 1933 It was very shy and did not spend the night there

*Tringa ochropus* L

Common and generally distributed, either around the lakes or along rivers or in dirty mud puddles Wing measurements, 5 males, 139-147 mm, 6 females, 142-145 mm

*Tringa stagnatilis* Bechst

A few present daily on Parwali Lake.

*Tringa glareola* L

Common in both districts, either singly or in small parties, scattered among the other waders

*Tringa totanus eurhinus* Oberh

A few at least were always present on Parwali Lake A male taken on February 28, 1933, was in nearly full breeding dress Others had not begun to molt

*Tringa erythropus* Pall

Flocks of up to a hundred of this very shy species often visited Parwali Lake They also fed along the drying canals at Ortu Wing measurements, 3 males, 162-173 mm; 4 females, 164-173 mm

*Tringa nebularia* (Gunn)

Not uncommon along the oxbow at Lahore, at Parwali Lake, and along the canals at Ortu Wing measurements, 3 males, 187-197 mm.; 3 females, 193-198 mm.

*Tringa hypoleucos* (L)

Occurred in small numbers at Parwali



*Philomachus pugnax* (L)

Occasionally flocks of about fifty visited Parwali Lake One was taken on February 12, and one on March 1, 1933

*Calidris minuta* (Leisl)

A flock seen almost daily on Parwali Lake, often mixed with dunlins Wing measurements, 9 males, 91-99 mm , 8 females, 94-99 mm

*Calidris temminckii* (Leisl)

Usually associated with the flocks of the preceding species, but less common They occurred at Lahore in small flocks along the oxbow, where specimens were taken on February 11 and 19, 1933

*Calidris alpina alpina* (L)

A small flock seen almost daily on Parwali Lake Wing measurements, 2 males, 115 and 116 mm , 4 females, 112-118 mm

*Capella gallinago gallinago* (L)

At least a few specimens usually to be seen at Parwali Lake Sometimes they all left for a few days On March 10, 1933, the largest flock was seen there The species also occurred at Lahore Wing measurements, 3 males, 128-136 mm , 3 females, 127-131 mm

*Lymnocyrtus minima* (Brünn)

Occasional specimens along the oxbow at Lahore and on Parwali Lake, but none were collected

*Pelecanus crispus* Bruch

At Parwali on February 26, 1933, two birds of this species appeared They stayed there till March 12

*Phalacrocorax carbo sinensis* (Shaw)

A flock of about fifty rested all day in a pond beside the city At evening they came to the Ortu canals to fish and by 8 A.M. were on their way back. The first specimens were collected on March 6, 1933 One had a white thigh patch but no white head feathers Another had a scattering of white on the breast.

*Anhinga melanogaster* Penn

A single bird seen in a tree beside a pond near Sirsa on January 29, 1933

*Platalea leucorodia leucorodia* L

Taken at the Ravi near Lahore in 1931. Common at Parwali and a daily visitor on the lake Four collected on March 5, 1933, contained only fish remains, chiefly otoliths and bones One had twenty-five small ear stones Usually from ten to thirty visited the lake, but on March 8 about sixty arrived, on the 10th, fifty Wing measurements, 5 males, 362-383 mm, female, 362 mm

*Pseudibis papillosa papillosa* (Temm & L)

In 1931 a flock of at least fifty was flushed from the trees at a village near Sirsa In 1933 only one was seen — a young male collected at Sirsa on February 24

*Ciconia ciconia asiatica* Sever

Seen only at Parwali First observed on February 26, 1933, when one landed On March 6 a small flock flew over, but on March 9 about a hundred came to the lake A collected male had in its stomach fourteen fish 10 inches long Wing measurement, 585 mm

*Dissura episcopus episcopus* (Bodd)

Rather common at Sirsa They came to Ortu at night to fish but disappeared during the day

*Xenorhynchus asiaticus asiaticus* (Lath)

Rather common at Sirsa They fed wherever any water remained, often following along the mud in dried canals Occurred singly or in flocks up to twenty Very shy A male taken on March 7, 1933, measures 75½ inches from tip of bill to tip of toes Its food was chiefly cattle dung, but it contained a fish also Wing measurements, 2 males, 597 and 602 mm.; female, 548 mm

*Leptoptilos dubius* (Gm.)

On March 12, 1933, an adjutant appeared and started to fish in Parwali Lake. It was very shy and soon left

*Ibis leucocephalus leucocephalus* (Penn)

Observed only at Parwali. They first appeared singly on February 8, 1933. On March 3 about a hundred landed on the lake. The first juveniles appeared on March 12. Two specimens taken on February 28 had dung of cow or sheep in the stomach and one had a small fish. The adults taken often had the neck feathers badly worn. Juveniles have no trace of pink and except for the characteristic bill might be taken for some other species.

*Ardea cinerea cinerea* (L)

Common in both areas. At Parwali there was a flock of from twenty to fifty of these birds that stayed all day on the lake. They left at night to fish in the canals at Ortu. They were always extremely wary. Only an adult male and a young female were collected.

*Casmerodius albus* (L)

One specimen came to Parwali Lake on February 6, 1933.

*Egretta garzetta garzetta* (L)

Not uncommon in both areas. Six were feeding on Parwali Lake on February 3, 1933.

*Bulbulcus ibis coromandus* (Bodd)

A few present in the rushes along the river at Lahore.

*Ardeola grayii* (Sykes)

Common and generally distributed in both regions, usually in dirty ponds and weedy ditches. Wing measurements, 4 males, 196-222 mm; female, 199 mm.

*Sarkidiornis melanotus* (Penn)

One specimen seen in the Lahore market on January 8, 1934.

*Anser indicus* (Lath.)

Seen only at Sirsa. A few were frequently present on Parwali Lake in 1933. They were last seen there on March 10, when thirteen came. Sometimes a flock of fifty or so flew over. In Lahore markets on February 22 there were fifteen. Two were collected at Parwali.

*Casarca ferruginea* (Pall )

Occurred on the Ravi and on Parwali Lake They were abundant at Parwali on February 27, 1933 None were taken

*Anas platyrhynchos platyrhynchos* L

Observed in abundance at Ortu on March 1, 1933, and at Parwali on the 8th One was collected.

*Anas poecilorhynchos poecilorhynchos* Forst

On March 5, 1933, I saw what I felt sure was a pair of these ducks at Parwali I have otherwise seen the bird in the district only in the takes of the netters, who bring them occasionally to the Lahore market

*Anas crecca crecca* L

Very common at Lahore and around Sirsa If ducks occurred anywhere they were either all teal or had some teal among them A census of the Lahore market on February 22, 1933, gives a fair sample of the abundance of the various duck species *Casarca ferruginea*, 15, *Anas platyrhynchos*, 5, *A. crecca*, 30, *A. penelope*, 1, *A. strepera*, 2, *A. acuta*, 15

*Anas acuta acuta* L

Observed in abundance on Parwali Lake on March 8, 1933 One specimen was collected

*Anas strepera* L

Rare and seen only at Parwali, in March, 1933 Two were collected

*Anas penelope* L

A few seen in the mixed flocks of ducks at Parwali in March, 1933. One specimen was taken.

*Spatula clypeata* (L.)

Observed in abundance at Ortu on March 1, 1933 Three specimens were collected.

*Nyroca fuligula* L

A male was seen on Parwali Lake on March 5, 1933 No specimens were taken

*Podiceps ruficollis* (Vroeg)

One seen daily on a pond beside Sirsa in February, 1931 Attempts to shoot it were futile It dived, and though there were no rushes or water weeds it never reappeared till I had left At Lahore they were common in the oxbow.

UNIVERSITY OF MICHIGAN

## THE USE OF BRUSH SHELTERS BY FISH IN DOUGLAS LAKE, MICHIGAN \*

IMMANUEL A. RODEHEFFER

**A**T THE 1938 meeting of the Michigan Academy the writer presented the results of studies made in 1934 and 1937 on the use of brush shelters by fish in six Michigan lakes (Rodeheffer, 1939). During the summer of 1938 the investigation was continued at Douglas Lake, Cheboygan County, Michigan, with the same shelters and the same methods of determining fish populations in or about the shelters and control areas that had been used in 1937. Details of the methods employed and the purposes of the study were stated in the previous paper. Further tests were needed to warrant the drawing of definite conclusions on several phases of the work undertaken in 1937.

In 1937 the fish populations about the shelters by day and by night showed differences that seemed to justify further day and night seining during the summer of 1938.

It had been realized for some time that additional study was needed to test the value of fertilizing shelters in order to make them more suitable habitats for fish. Therefore, in both 1937 and 1938 certain shelters at Grapevine Point in Douglas Lake were fertilized with barnyard manure.

The results of the studies outlined above are given here. A report on the use of brush shelters as a continuous summer habitat, as well as information regarding the movements of fishes (which it is hoped may be successfully determined by tagging and fin clipping), will be delayed, pending the completion of further investigations.

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#### INSTALLATION OF SHELTERS IN 1938

In 1937 ten shelters were placed in Douglas Lake at Grapevine Point. In a further effort to ascertain the relation of the brush shelters to the concentration and localization of the fish populations in given parts of a lake four additional shelters were placed just north of Hook Point in North Fishtail Bay in 1938. In this location the depth gradually increases to 8 to 12 feet at the drop-off, which lies 150 to 200 feet from shore. The bottom of the shoal, composed chiefly of sand, is covered by a layer of flaky marl ranging in thickness from a small fraction of an inch to about two inches and is almost devoid of rooted vegetation in water less than eight feet deep. In deeper water on the shelf near the drop-off and on the steep slope beyond there is some submerged vegetation.

The shelters, constructed according to directions by Hubbs and Eschmeyer (1938), comprised a hollow-center square shelter ( $22 \times 22$  feet), a pole shelter ( $18 \times 28$  feet), a ladder shelter ( $14 \times 16$  feet), and a circular shelter (12 feet in circumference). With the exception of the square and the pole shelters, which were separated by a distance of 200 feet to provide a control area, the structures were placed approximately 90 feet apart. They were larger and were less densely packed than those used at Grapevine Point in 1937 and 1938. They were too large to be entirely pulled out of the lake during the seining, but the clearness of the water made it possible to see that no fish stayed in the brush when brought to the shore.

In the area where these shelters were later placed four seine hauls made on July 20, 1938, with the 140-foot seine which had been used in 1937, caught 2 small-mouthed bass, 9 sand shiners, 3 spot-tailed shiners, 1 blunt-nosed minnow, 79 clams, and 1 crayfish. The results of this seining agree with those of similar seining at Grapevine Point in 1937 in confirming the general observation that such shoal areas in Douglas Lake are relatively barren of fish life.

## RESULTS OF SEINING IN 1937 AND 1938

Data were obtained on the number of fish of each species taken per seine haul about the shelters and in the control areas (Table I). The results at Grapevine Point for 1937 and 1938 are in essential agreement. Rock bass, perch, pumpkinseed sunfish, small-mouthed bass, and large-mouthed bass, which were the common game species, ranked in abundance in the order given. Considering together the

TABLE I

NUMBER OF FISH OF EACH SPECIES TAKEN PER SEINE HAUL ABOUT SHELTERS AND IN CONTROL AREAS IN DOUGLAS LAKE

Numbers in parentheses indicate number of seine hauls  
Values less than 0.05 are designated "tr" (trace)

SPECIES OF FISH	Grapevine Point 1937		Grapevine Point 1938		North Fishtail Bay 1938	
	Shelters (36)	Controls (23)	Shelters (40)	Controls (23)	Shelters (15)	Controls (4)
<b>GAME FISHES</b>						
Rock bass	40.7	0.4	39.6	1.2	24.8	2.0
Yellow perch	14.4	8.7	34.3	25.7	13.5	31.7
Pumpkinseed	7.0	1.0	7.6	0.9	17.6	2.8
Small-mouthed bass	4.4	3.1	3.0	1.9	3.9	6.5
Large-mouthed bass	0.6	0.1	0.2	tr	4.3	0.8
Northern pike			0.1		0.2	
Bluegill	0.1					
<b>COARSE FINNES</b>						
White sucker	1.7	2.0	2.3	0.5	4.5	1.5
Brown bullhead	0.1		0.1		1.6	
<b>FORAGE FISHES</b>						
Common shiner	0.7	0.7	3.6	2.3	0.9	11.5
Spot-tailed shiner	2.2	5.2	2.6	2.0	4.3	2.5
Log perch	1.6	2.5	3.0	1.0	1.3	0.8
Sand shiner	0.6	0.3	1.7	1.3		
Blunt-nosed minnow	0.1	0.1			2.8	
Johnny darter	0.3	0.8	0.3	0.2	0.5	0.8
Trout-perch	0.1		tr			
Iowa darter	tr.	0.1				
Muddler					0.1	
<b>Total fish</b>	<b>74.6</b>	<b>25.0</b>	<b>98.4</b>	<b>37.0</b>	<b>80.3</b>	<b>60.9</b>



results of the day and night seining (as presented in Table I), one sees that rock bass and pumpkinseeds displayed a very strong preference for the brush devices, whereas perch, small-mouthed bass, and most other fishes were not consistently attracted to the shelters.

As would be expected (Hubbs and Bailey, 1938), the number of large-mouthed bass taken per seine haul in the quieter, weedier, and more roily waters of North Fishtail Bay was greater than at Grapevine Point, which is more exposed. All data indicate that this species showed a decided preference for the brush rather than for the open shoals. The relative numbers of small-mouthed bass taken in the covers and in the control areas of the two habitats are not so easily explainable.

Although Douglas Lake has a fairly good reputation for pike fishing, no northern pike were obtained in the seining in 1937. In 1938 only one was caught at Grapevine Point, but it was recaptured several times, and only three were seined at North Fishtail Bay. Apparently pike do not inhabit brush shelters, or, at least, those located in comparatively shallow water.

The total number of fish taken per seine haul in 1938 was higher in both shelters and control areas than in 1937. This result may largely be explained by the greater amount of night seining in 1938, in which perch were taken in larger numbers than in the daytime.

#### THE REPOPULATION OF BRUSH SHELTERS AFTER THE REMOVAL OF ALL FISH

To determine to what extent and how rapidly brush shelters are repopulated all fish removed from the shelters and control areas north of Hook Point were carried in a straight line a distance of about 0.6 mile across North Fishtail Bay and were released in the small sheltered bay which lies to the east of East Point. All game fish of sufficient size were marked with numbered jaw tags, in the manner described by Shetter (1936), to permit identification of any that returned to the artificial covers. These shelters were removed fifteen times and the control area was seined four times between August 3 and 22, 1938. The number of fish taken per haul in North Fishtail Bay (see Table I) represents, therefore, new arrivals on the seining grounds. Nevertheless, the indicated abundance of fish here compared favorably with the determinations for Grapevine Point,

where the fish seined were not transported to another locality. Although the conclusion is weakened by the fact that the experiment and the control were performed in different parts of the lake, with distinctive conditions, the data suggest that fish may concentrate to a certain degree in areas provided with brush protection, and that if these fish are removed others take their place until the original concentration is approximately duplicated. However, the number of rock bass taken in hauls after the initial removal was always less than in the first seining. Nineteen of the 497 fish tagged and planted across the bay were retaken in the shelters.

GAME FISH TAKEN ABOUT BRUSH SHELTERS AND  
IN CONTROL AREAS BY DAY AND BY NIGHT

By quantitative seining in Douglas Lake many data were gathered on the number and size of individuals of each species of game fish found in and about the brush shelters and in the control areas by day and by night (Tables II-III). Marked differences were discovered in comparing the species and in contrasting the data for shelters and control areas and those for day and night occurrences of fish.

As previously stated, rock bass (Table II) congregated in notable abundance about the brush, though only during the day. At night about three fourths of them deserted the cover, but at no time were commonly seined in the control areas. Therefore at night they must either have scattered over the shoals (as suggested by the greater number there at that time) or have moved into deep water. In the control areas as well as about the brush the rock bass seined by day averaged larger than those taken at night. Less than 7 per cent of the 3,345 rock bass from about the brush were of legal size (6 inches). In Douglas Lake this species of fish is considerably dwarfed.

Pumpkinseeds (Table II) were less common than rock bass, but the differences in number by day and by night and in the shelters and control regions were about the same. They were very strongly attracted to the brush, but not so much as the rock bass. Almost three fifths of those inhabiting the covers by day deserted them at night, when a marked increase in the always low number occurring on the open shoals was noted. Less than 5 per cent of the 800 pumpkinseeds from the shelters exceeded the minimum legal size (6 inches).

The most interesting item in the data for perch (Table III), as

TABLE II

TOTAL NUMBER, NUMBER PER SEINE HAUL, AND SIZES (TOTAL LENGTHS IN CENTIMETERS) OF ROCK BASS AND PUMPKINSEED SUNFISH TAKEN IN BRUSH SHELTERS AND CONTROL AREAS BY DAY AND BY NIGHT IN DOUGLAS LAKE IN 1937 AND 1938

Place, date, and number of hauls	Sizes of fish and hauls	Rock bass				Pumpkinseed			
		Shelters		Controls		Shelters		Controls	
		Day	Night	Day	Night	Day	Night	Day	Night
Grapevine Point, 1937	Min size	22	30	25		25	52	90	105
No of hauls	Ave size	94	86	59		105	108	117	125
Shelters Day, 23	Mode size	9-10	6-7	2-3		10-11	10-11	?	?
Night, 3	Max size	212	160	124		200	160	170	160
Controls Day, 21	No of fish	1349	74	9		221	23	17	7
Night, 2	No per haul	407	247	04		67	77	08	35
Grapevine Point, 1938	Min size	14	23	30	24	26	32	30	69
No of hauls	Ave size	101	66	48	52	90	93	106	110
Shelters Day, 31	Mode size	12-13	6-7	?	3-4	6-7	6-7	?	?
Night, 9	Max size	240	146	59	136	180	184	145	170
Controls Day, 19	No of fish	1476	74	3	20	279	24	8	11
Night, 4	No per haul	476	82	02	50	90	27	04	28
North Fishtail Bay, 1938	Min size	25	32	46	37	35	30	100	60
No of hauls	Ave size	111	104	65	70	77	75	138	108
Shelters Day, 12	Mode size	7-8	?	6-7	7-8	6-7	6-7	?	?
Night, 3	Max size	231	171	128	90	189	166	169	139
Controls Day, 3	No of fish	364	8	2	6	243	20	8	3
Night, 1	No per haul	303	27	07	60	21	67	27	30
Combined data	Min size	14	23	25	24	25	30	30	60
No of hauls	Ave size	99	77	58	56	90	93	120	115
Shelters Day, 76	Mode size	9-10	6-7	6-7	3-4	6-7	6-7	?	?
Night, 15	Max size	240	171	128	135	200	184	170	170
Controls Day, 43	No of fish	3189	156	14	26	748	67	33	21
Night, 7	No per haul	420	104	03	37	98	45	08	30

contrasted with the information on the rock bass, is their increased abundance on the shoals at night, particularly in the control areas. Here they were indicated to be 24.9 times as numerous by night as by day. About the shelters they were taken 2.6 times more frequently at night. The shelters proved the more attractive in daylight, when the abundance in the brush was found to be 4.2 times that in the open. At night, in contrast, the number of fish in the shelters was less than half that in the control areas. Obviously the perch which abound in the offshore weed beds in Douglas Lake tend to move to the shoals at night, and largely desert the shallows during the day, especially where there is no cover. The perch, taken by day around the brush constructions averaged somewhat larger than those

TABLE III

TOTAL NUMBER, NUMBER PER SEINE HAUL, AND SIZES (TOTAL LENGTHS IN CENTIMETERS) OF PERCH AND SMALL-MOUTHED BASS TAKEN IN BRUSH SHELTERS AND CONTROL AREAS BY DAY AND BY NIGHT IN DOUGLAS LAKE IN 1937 AND 1938

Place, date, and number of hauls	Size of fish and hauls	Perch				Small-mouthed bass			
		Shelters		Controls		Shelters		Controls	
		Day	Night	Day	Night	Day	Night	Day	Night
Grapevine Point, 1937	Min size	35	45	35	42	14	52	40	45
No of hauls	Ave size	113	93	113	97	95	134	78	63
Shelters Day, 33	Mode size	13-14	9-10	4-5	4-5†	6-7	14-14†	5-6	†
Night, 3	Max size	185	190	180	143	225	182	160	120
Controls Day, 21	No of fish	488	112	179	21	143	8	65	5
Night, 2	No per haul	118	372	85	105	43	27	31	25
Grapevine Point, 1938	Min size	24	30	41	42	40	46	45	41
No of hauls	Ave size	120	101	93	99	96	115	100	109
Shelters Day, 31	Mode size	11-12	9-10	†	9-10	6-7	4-6	6-7	†
Night, 9	Max size	197	105	135	142	293	392	363	154
Controls Day, 19	No of fish	813	548	6	584	106	12	38	5
Night, 4	No per haul	262	609	03	1460	34	13	20	13
North Fishtail Bay, 1938	Min size	35	75	50	45	42	49	42	50
No of hauls	Ave size	107	112	50	90	79	59	62	62
Shelters Day, 12	Mode size	12-13	9-10†	†	5-6	6-7	5-6†	6-7	†
Night, 3	Max size	187	154	50	143	240	70	128	65
Controls Day, 3	No of fish	171	32	1	125	50	7	23	3
Night, 1	No per haul	143	107	03	1250	42	23	77	30
Combined data	Min size	24	30	35	42	14	46	40	41
No of hauls	Ave size	116	100	112	95	93	106	82	80
Shelters Day, 76	Mode size	11-12	9-10	4-5	9-10	6-7	5-6†	6-7	†
Night, 15	Max size	197	105	180	143	293	392	363	154
Controls Day, 43	No of fish	1372	692	186	730	299	27	126	13
Night, 7	No per haul	181	461	43	1071	39	18	29	19

taken at night, and the same relation held for the control areas, except at one day seining, when a school of small perch was secured. Almost 3 per cent of the perch seined about the brush were of legal size (6 inches), but it should be recalled that the perch in Douglas Lake are markedly dwarfed (Weller, 1938).

Small-mouthed bass (Table III) were not taken in the shelters as commonly as the three species already mentioned and were not much more numerous in the brush than on the open shoals. In both areas they were seined even less frequently at night than by day. Only 2 of the 326 small-mouthed bass seined from the shelters were more than 10 inches long.

Large-mouthed bass were taken in even smaller numbers, but

they revealed a greater preference for the shelters. Of the 102 seined 95 were from the brush, 81 by day and 14 by night, 7 were taken in the control areas, 5 by day and 2 by night. The numbers per seine haul under these four conditions were 1, 1, 0, 1, and 0, 3, respectively. None of legal size were caught.

It may be concluded that great changes occur from day to night in the fish populations around the shelters and on the unprotected shoals. We can only wonder where the young and the half-grown fish go when they desert the cover. If the legal-sized fish of these species show as much fluctuation in their habitats, is it surprising that fishermen often complain of not being able to catch them? Most assuredly little is known of the movements or the habits of our game fishes.

#### THE VALUE OF FERTILIZING SHELTERS

To learn whether fish congregate more heavily in shelters that are fertilized two burlap sacks full of barnyard manure were added to shelter 1 and one sack was added to each of shelters 4, 7, 8, and 9 on July 21, 1937, and again on July 15, 1938. Shelters 2, 3, and 10, serving as controls, were not fertilized. These structures, all located

TABLE IV

FISH TAKEN PER SEINE HAUL IN THE FERTILIZED AND UNFERTILIZED SHELTERS IN DOUGLAS LAKE IN 1937 AND 1938

<i>Species of fish</i>	<i>In fertilized shelters (41 hauls)</i>	<i>In unfertilized shelters (25 hauls)</i>
<b>Game Fishes</b>		
Rock bass	50.8	38.2
Yellow perch	28.7	25.9
Pumpkinseed	8.9	6.8
Small-mouthed bass	3.7	3.8
Large-mouthed bass	0.6	0.4
Bluegill	...	0.1
Northern pike	0.1	
<b>Total, game fishes</b>	<b>92.8</b>	<b>75.2</b>
<b>Coarse Fishes</b>		
White sucker	1.6	3.8
Brown bullhead	0.1	0.1
<b>Total, forage fishes</b>	<b>11.4</b>	<b>12.2</b>
<b>Grand total</b>	<b>105.9</b>	<b>91.3</b>

at Grapevine Point, were described in the previous report (Rodeheffer, 1939).

In 1937 filamentous algae grew in profusion on the recently placed fertilized shelters. There were some on the unfertilized covers, but not so many. In 1938 no algal growth was noticeable on any of the shelters. A quantitative study (unpublished) has been made by Mr O W Young on the organic growths on the brush of the fertilized and the unfertilized shelters.

The results of the experiment (Table IV) are not conclusive, though the fish population seemed to be somewhat greater in the fertilized shelters. The fish which most consistently inhabited the brush shelters and which seemed to have a preference for the fertilized ones were rock bass and pumpkinseeds. It was not determined whether the fish in the fertilized shelters showed an increased rate of growth or, indeed, whether individual fish inhabit a given shelter continuously enough to allow a test of the effects of the fertilizer on their growth.

#### SUMMARY

The evidence of the second summer's study of brush shelters in Douglas Lake supports the views that.

- 1 Young and half-grown fish of certain species seek the protection of brush shelters, especially during the day

- 2 Shelters are repopulated as fish inhabiting them are removed.

- 3 The fish population about the shelters, as well as on the open shoals, is subject to great individual changes, which need to be considered in checking their use of the shelters.

- 4 Fertilizing shelters with barnyard manure, although appearing to be of some value in attracting certain species of fish, may not prove effective enough to justify the cost

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LIST OF SCIENTIFIC AND COMMON NAMES OF FISHES  
MENTIONED IN THIS REPORT

<i>Catostomus c. commersonni</i>	Common white sucker
<i>Notropis cornutus frontalis</i>	Northern common shiner
<i>Notropis h. hudsonius</i>	Great Lakes spot-tailed shiner
<i>Notropis deliciosus stramineus</i>	Northern sand shiner
<i>Hyborhynchus notatus</i>	Blunt-nosed minnow
<i>Ameiurus n. nebulosus</i>	Northern brown bullhead
<i>Esox lucius</i>	Northern pike
<i>Percopsis omiscomaycus</i>	Trout-perch
<i>Perca flavescens</i>	Yellow perch
<i>Percina caprodes semifasciata</i>	Northern log perch
<i>Boleosoma n. nigrum</i>	Central Johnny darter
<i>Poecilichthys exilis</i>	Iowa darter
<i>Micropterus d. dolomieu</i>	Northern small-mouthed bass
<i>Huro salmoides</i>	Large-mouthed bass
<i>Lepomis macrochirus</i>	Bluegill
<i>Lepomis gibbosus</i>	Pumpkinseed
<i>Ambloplites rupestris</i>	Rock bass
<i>Cottus bairdii</i>	Northern muddler

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## LARGER LAND SHELLS FROM PINE WOODS IN NORTHERN MICHIGAN

HENRY VAN DER SCHALIE

**D**URING the summer of 1938 I was given an opportunity<sup>1</sup> to collect land shells in areas of northern Michigan which hitherto have not been carefully surveyed. My wife, who is somewhat conversant with ecological botany, accompanied me on the trip. In the course of this work we found that the larger species of land shells were not present in most regions where pine predominates. This is not a new discovery, but is in agreement with the experience of many collectors who have worked in eastern United States.

It is striking that so few references to this condition have been made in our conchological literature. Three definite statements were noted, however. A. G. Wetherby (1880, p. 37) published the following observation in regard to collections made twenty miles north of Beaumont, Texas. "At this locality, where any fragment of bark, any chip, or any log of other timber was found to be inhabited by the mollusks, the pine logs were invariably barren, and such I have observed to be the case in Tennessee, Kentucky and North Carolina, and the rarity of land shells in forests, almost or exclusively pine, is a fact well known." Victor Sterki (1892, p. 118) took issue with Wetherby's statement and cited from his own experience instances of the finding of land shells in Switzerland, where they are abundant in pine forests. H. A. Pilsbry (1892, p. 118) came to the defense of Wetherby and pointed out that in eastern United States "We have always found that land shells are rare in pine woods." To bring this matter nearer our Michigan region, Bryant Walker (1902, p. 1955) wrote: "Coniferous forests are usually quite barren of molluscan life. An open hardwood forest in a limestone region is the ideal hunting ground."

In view of these statements we were greatly surprised to find in the summer of 1938 a remarkably rich molluscan fauna in a coniferous

<sup>1</sup> An expedition made possible by a grant from the H. H. Rackham School of Graduate Studies



area in the northwestern portion of the peninsula lying between Little Bay de Noc and Big Bay de Noc, Delta County, Michigan. At this station the vegetation consisted largely of jack pine, with a few scattered Norway pine, spruce, red oak, and aspen. When we first entered the zone we felt that because of the preponderance of conifers it would be impossible to obtain land shells. Nevertheless, the effort to collect was well repaid, as is evidenced by the following list of species taken at this station:

<i>Species</i>	<i>No of specimens</i>	<i>Species</i>	<i>No of specimens</i>
<i>Polygyra albolabris</i> (Say)	12	<i>Zonitoides arboreus</i> (Say)	5
<i>Polygyra fraterna</i> (Say)	14	<i>Strobilopsis labyrinthica</i> (Say)	1
<i>Euconulus fulvus</i> (Müller)	7	<i>Retinella indentata</i> (Say)	1
<i>Euconulus chersinus</i> (Say)	4	<i>Pallifera dorsalis</i> (Binney)	1
<i>Gonyodiscus cronkhitei</i> cataskillensis Pilsbry	6		

To find a satisfactory explanation for this apparent anomaly is not simple. Observations at approximately one hundred stations established during the course of the summer's work lead us to believe that in this particular area there is a marked departure from the usual correlation of the land-shell fauna, the geology, and the vegetation.

Geologically the station is situated in a limestone region which occupies a broad zone along the north shore of Lake Michigan. A limestone cliff of Ordovician age and belonging to the Cincinnati series forms the characteristic bluffs along the west side of this peninsula. It is natural, then, for land shells to be abundant here. Pine would not normally be expected, however, in such a prominent limestone belt. In an effort to account for the presence of this jack pine investigators who have been interested in the plant ecology of northern Michigan for some years were consulted. Unfortunately, they had not studied this region, and could give no clue to the solution of the problem.

M. L. Fernald (1919, p. 52) has shown that jack pine (*Pinus Banksiana*) is invariably associated with acid soils. "These facts and many scores of monotonously similar ones which the writer refrains from merely piling up are sufficient evidence that the Banksian pine is a pronounced *oxylophyte*." If this is true — and there is every reason to believe that it is — the presence of jack pine in the

limestone region under consideration would indicate that there is a marked difference in the alkalinity of the surface soil and its limestone substratum. On the other hand, the occurrence of larger land shells is perhaps an equally important indicator of an alkaline surface soil. The exact relationships of both the mollusks and the jack pine to the soils in this region are consequently much in need of further investigation.

As a rule, limestone, hardwoods, and land shells are correlated in nature. Here is a case in which the presence of larger land shells is in agreement with the underlying soil conditions, but is inconsistent with the vegetation. Apparently, in limestone areas the vegetation may vary without materially affecting the molluscan life. This leads us to suspect that in his report on the land mollusca of Cheboygan County Allan Archer may have failed to take into account the fact that much of Cheboygan County is in a limestone belt. The geological factor may have been more important in explaining the presence of the five species of land shells he reports from "pine woods" than he may have realized. In view of this we should not accept without further study his statement (1936, pp. 1-2) that "The vegetation appears to exercise a more powerfully modifying influence on the assemblages of mollusks than does the soil."

In conclusion, we believe that the contentions of earlier workers, that coniferous forests in eastern United States are usually barren of molluscan life, are in general valid. In regions such as northern Michigan, however, where the vegetation may not always be in agreement with the geological conditions of an area, changes in the fauna may appear which represent a marked variation from what might normally be expected within the vegetative cover. As yet but little is known about the ecology of many of our land shells, so that we can hardly do more than call attention to the conditions observed.

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# **GEOGRAPHY**



## A LAND-TYPE MAP OF LIVINGSTON COUNTY, MICHIGAN

W BRUCE DICK† AND STANTON J WARE

**I**N ANY land-classification program it is important to recognize the interrelationships of qualities of the soil, slope, drainage, relief, and, to a certain extent, of the natural vegetation. These land qualities present a varying pattern from one locality to another. They form a basis for measuring differences in types of land. By observing in the field the complex of these qualities a unit of land or a type may be established. Combinations of elements which make up a land type are recognizable from one area to another, and the land types may be mapped as definite entities. Frequently the use of the land or the condition of farms reflects a fundamental relationship to land types, and tends to accentuate their importance.

In the summer of 1938 a land-type classification was developed for Livingston County (Fig 1) and a quantitative measure applied to each land unit. The first step in field procedure consisted of extensive travel by automobile to become familiar with the local arrangements of land qualities and to identify various combinations of these for purposes of establishing land types. It was then possible to begin actual mapping.

Every road within the county was traversed. Positions on the map were calculated by measuring with an odometer the distance traveled. Thus, when it was decided that the limits of a land type had been reached, the boundary was drawn in.

The completed map (Fig 2) shows twelve separate types. Seven had previously been recognized in adjacent Oakland County by J O Veatch and N. L. Partridge,<sup>1</sup> and the types and names used

† **Errons' Note**—Mr. Dick died on October 28, 1939, of injuries received in an automobile accident. His death removes from the University campus an engaging personality as well as an enthusiastic young research worker.

<sup>1</sup> From an unpublished land-type map of Oakland County, Michigan, by J O Veatch and N. L. Partridge, Michigan State College, East Lansing, Michigan.



**376-377** Three types, which are well contrasted, have been selected for further exposition the Eau Claire, in the vicinity of Fowlerville, the Oronoko, in the southern part of the county, and the Beebe, to the east of the city of Howell

#### EAU CLAIRE TYPE

The Eau Claire land type is characterized by gently rolling till or clay plains, with short slopes, usually less than 7 per cent, and heavy loam soils (Pl I, Fig 1) Swales and shallow depressions are not uncommon, and they frequently require artificial drainage for their full agricultural utilization Farms in this land type are considered among the best in the county The level land and friable soil lend themselves well to the use of power equipment in farming operations

#### ORONOKO TYPE

In contrast to the Eau Claire type is the Oronoko, with its hilly knob-and-basin terrain (Pl I, Fig 2) Here are steep slopes, lakes, and swamps The soils are mainly sandy loams The slopes range chiefly from 7 to 25 per cent Oronoko includes the roughest moranic country to be found within the county Erosion presents a problem to the farmers in this land type, because the combinations of steep slopes and sandy loam soil lead to serious gullying and surface wash (Pl II, Fig 1) Much of the land is pastured, but under the dry conditions of midsummer it is difficult to maintain livestock in the usual numbers Many of the hills are cropped, but the slopes and gullies prevent the use of power machinery and greatly restrict that of the plow Under these conditions farmers have turned many of their fields into permanent sheep pastures

#### BEEBE TYPE

The third illustration is the Beebe type Flat swamp land made up of organic and poorly drained mineral soils characterize this low-land type (Pl II, Fig 2) Considerable portions are in tree cover, willow brush, and sedge The forest floor is usually wet and soft, with occasional shallow pockets of standing water. The type is not very extensive in this county, and in the two areas where it does occur farmers utilize parts of it for summer pasture and allow their stock to browse and feed on the swamp grasses



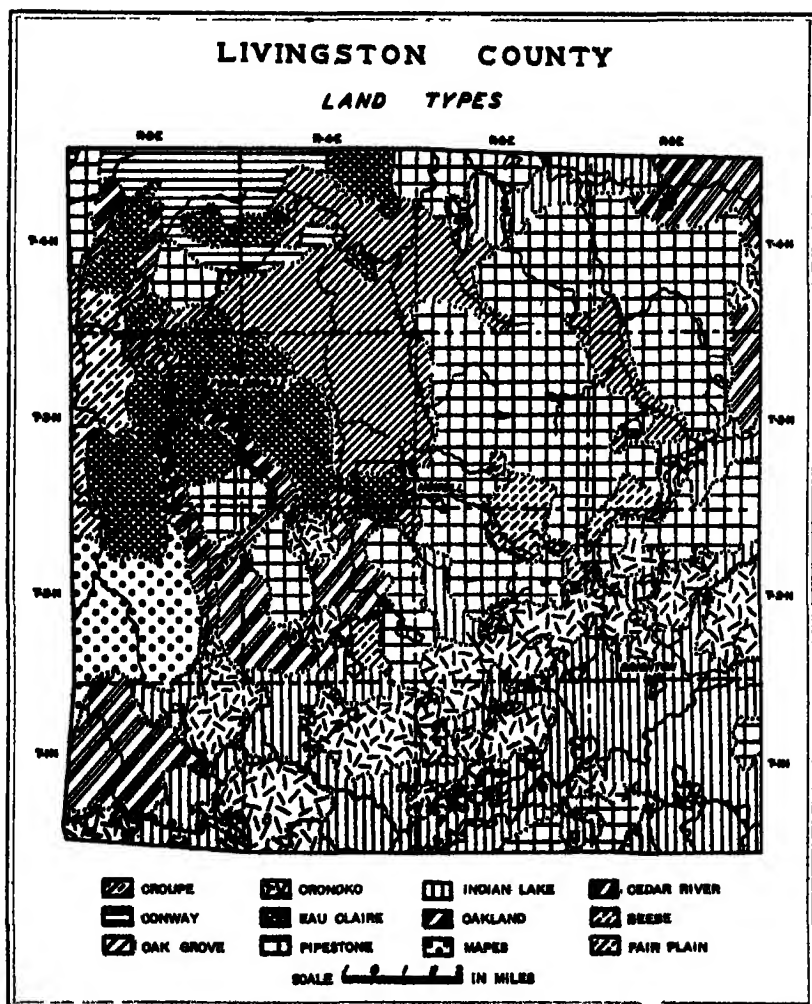


FIG 2

## SUMMARY OF THE LAND TYPES SHOWN IN FIGURE 2

**Croupe** — Surface similar to that of the Eau Claire type, but broken by old river valleys, now cut to a considerable extent by artificial drainage ditches. Some swamp, but very little standing water. No lakes. Only small amount of wild land. Soils very heterogeneous, mainly of the lighter types. Patches of Hillsdale, Plainfield, and Fox with associated stream-bottom types of soil.

*Conway* — Surface smooth to gently rolling, with large areas of very flat, artificially drained land, which at one time had been wet. Idle and pasture land predominant. Dominant soils Fox series with muck. Artificially drained Carlisle muck, which has been cleared for agriculture.

*Oak Grove* — Rolling to hilly surface. Intermediate in relief between Oronoko and Eau Claire types. Considerable land in pasture. Soils dominantly Coloma loamy sand with Carlisle muck bordering the streams. Minor soils, Miami and Plainfield series. Sandier exposed hills subject to blowing in dry weather.

*Oronoko* — Hilly, knob-and-basin terrain. Slopes two to three times the area of level upland, high percentage of slopes, 15 to 25 or more, lake basins, dry depressions, and swamp basins. Dominant soils sandy loams mainly Bellefontaine and Hillsdale types, with smaller bodies of Coloma, Miami, and Fox or Fox-like soils.

*Eau Claire* — Gently rolling till or clay plains. Short slopes, few exceeding 7 to 15 per cent, swales and shallow basins. Dominantly Miami and Hillsdale loam types of soil. May be moderately stony.

*Pipestone* — Deeply rolling or broken, pitted or dissected clay land, till plains, or moraines. Slopes greater in area than level land, constructional swales and basins, generally considerable stream dissection. Dominant soils Hillsdale and Miami types. Some muck and peat.

*Indian Lake* — Sand-gravel plains, level surface but containing a large number of dry potholes, lake basins, muck and peat basins, swampy stream valleys, or chains of lakes. Slopes short, enclosing basins for the most part, but may include those up to 25 per cent or more. Dominant soils Fox and Bellefontaine. Some Plainfield and the organic soils.

*Oakland* — Intermediate in gradient and height of relief between Eau Claire and Pipestone on the one hand and Oronoko on the other; more Hillsdale and Miami soils than are found in Oronoko type. Slopes exceed area of level land, high percentage of slopes of 7 to 25 per cent gradient. Lakes and muck basins common. Dominant soil Hillsdale or sandy Miami; less Bellefontaine. May be stony.

*Mapes* — Level swampy land with interspersed higher areas having slopes generally less than 7 per cent. Dominant soils Carlisle muck and Hillsdale sandy loam. May include some Fox soils. Wild land predominant with patch cultivation on the interspersed highlands. Lower relief and fewer lakes than in the Indian Lake type.

*Cedar River* — Level, broad valley bottoms. Slow stream drainage with some artificial drainage. Similar to the Mapes type, but with little or no associated Hillsdale soil. Generally sinuous in outline. Soils mainly Carlisle muck. There may be small areas of Rifle peat. Surrounding upland chiefly Miami loam.

*Beebe* — Swamp land mainly Carlisle muck and Rifle peat, with small amounts of poorly drained mineral soils.

*Fair Plain* — Smooth sand-gravel plains, only slightly pitted or undulating. Few lakes and muck basins. Few slopes more than 10 per cent. Dominant soils Fox series.

**TABLE I**  
**DATA ON QUANTITATIVE LAND TYPES**

Land types	Date July 1938	Distance of traverse (in miles)	Percentage of total distance in slopes					No. of land components per mile of traverse						Percentage of total distance in soils									
			Percentage of total distance in slopes					Streams	Catholins	Potholes	Swamps	Lakes	Swales	Well drained*					Poorly drained†				
			0-3% (Lowland)	3-8% (Upland)	9-15%	15-25%	25-35%							1	2	3	4	5	6	7	8	9	10
Drenoko	18	2.60	17.30	5.77	28.82	42.80	5.77	77	38	38	77	38	0	0	70.9	0	0	0	0	0	23.1		
	19	9.35	12.83	0	3.31	40.10	43.90	.54	75	1.82	54	0	0	0	85.0	1.6	0	3.2	0	10.2			
	20	3.40	8.83	0	0	45.60	43.60	0	59	.29	0	0	0	0	45.6	4.6	0	0	0	8.8			
	21	1.63	34.40	0	0	65.00	0	62	0	0	1.25	2.50	2.50	0	65.6	0	0	0	0	34.4			
	Total	16.95	14.78	.57	6.20	44.00	34.20	47	1.12	1.12	53	71	24	0	74.0	10.0	0	1.8	0	14.2			
	18	4.60	0	100.00	0	0	0	44	22	0	0	0	.22	0	0	90.3	3.3	0	6.5	0	0		
Een Claere	20	.50	0	100.00	0	0	0	0	0	0	0	0	0	0	100.0	0	0	0	0	1.8			
	21	8.20	1.83	86.70	2.44	0	0	37	12	0	12	0	73	0	0	98.2	0	0	3.4	0			
	27	10.80	3.34	91.68	5.00	0	0	.28	.37	0	0	0	37	0	0	96.6	0	0	0	0			
	28	1.70	0	100.00	0	0	0	0	0	0	0	0	59	0	0	100.0	0	0	0	0			
	Total	25.85	1.94	85.10	2.90	0	0	31	23	0	0	0	45	0	0	96.3	5	0	2.5	6	0		
	18	8.70	2.70	2.70	74.38	20.24	0	135	102	0	81	.27	27	0	0	97.3	0	0	2.7	0	0		
Fipstone	19	2.35	0	54.30	44.70	0	0	0	1.70	1.70	0	0	0	0	30.2	63.8	0	0	0	0	0		
	20	19.40	10.07	2.84	71.40	15.71	0	.26	1.08	.46	41	0	21	0	.8	86.1	0	2.6	1.0	9.5	0		
	21	4.55	0	13.30	86.80	0	0	22	.88	0	22	0	22	0	0	100.0	0	0	0	0	0		
	27	8.70	6.82	2.88	81.00	9.77	0	23	35	0	.58	0	115	0	4.6	89.0	0	0	4.6	17	0		
	28	7.35	2.04	2.04	60.60	18.38	10.89	27	14	0	0	68	27	122	0	0	98.0	0	0	2.0	0		
	Total	48.05	5.97	6.40	73.85	13.05	1.74	.33	83	.28	43	07	54	1.2	1.8	89.7	0	1.1	1.3	4.9	0		
Fair Plain	18	.80	0	0	100.00	0	0	0	3.78	18.80	0	0	0	0	0	0	0	100.0	0	0	0	0	
	18	4.20	9.54	35.70	38.10	16.06	0	71	.45	.24	24	0	0	0	0	0	0	83.4	10.7	0	0	0	
	19	10.25	7.32	27.29	44.44	22.92	0	.86	1.17	.49	.29	0	49	0	0	92.6	0	0	0	0	0		
	20	10.65	26.30	9.38	64.30	9.38	0	35	17	.47	38	19	0	0	0	74.6	12.2	0	0	28.54	0		
	21	2.28	20.00	33.45	20.00	21.55	0	.31	1.23	0	1.54	0	92	0	0	90.0	0	0	6.2	7.7	6.2		
	27	2.90	0	100.00	0	0	0	0	1.68	0	.53	79	1.32	0	0	82.9	17.1	0	0	0	0		
Indian Lake	28	2.96	5.08	0	45.60	49.40	0	76	.51	0	.51	23	2.52	6.38	6	0	0	0	0	5.1	6.4		
	Total	36.10	13.30	15.36	52.75	18.55	0	61	.86	.34	47	34	.50	7.73	9	5.4	0	9.7	1.8	2.1	6.4		



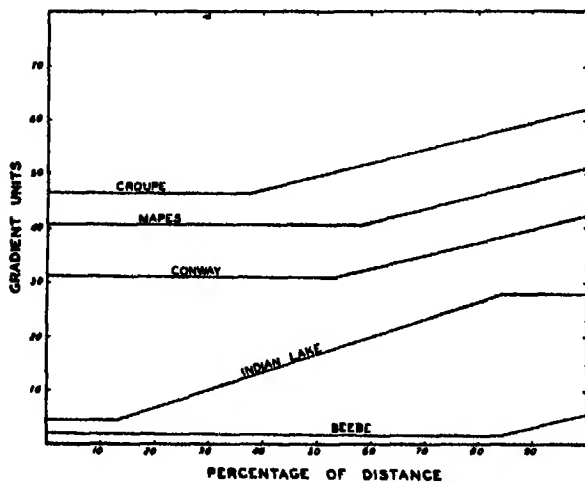


FIG 3 Land-type slopes

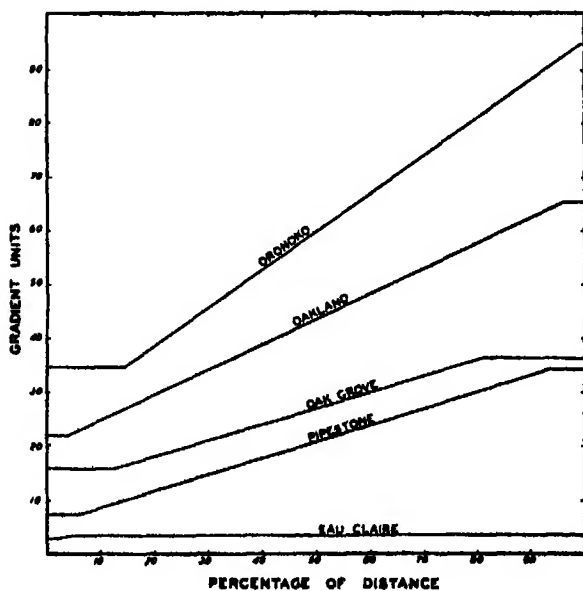


FIG 4. Land-type slopes

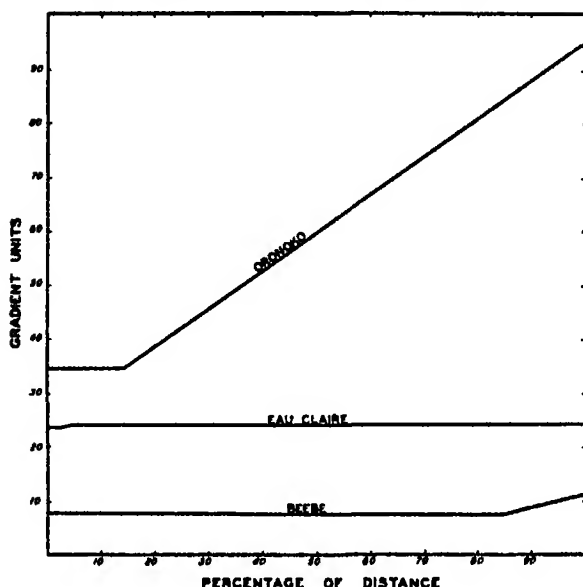


FIG 5 Land-type slopes

## CONCLUSIONS

After completion of the land-type map it seemed desirable to check the land divisions quantitatively. The traverse method was employed for this purpose, three north-south and three east-west traverses of the county were made. Odometer readings in twentieths of a mile were recorded to measure distances in each percentage-of-slope category and in each soil division. At the same time streams, catholes, swales, lakes, and swamps were tallied as they were encountered on the traverse. Slope and soil divisions were worked out on the basis of percentage of total distance in each land type, whereas the other land qualities were figured on the basis of number per mile. This provided a means for comparing these elements quantitatively.

The results of these calculations have been tabulated (Table I, pp 378-379). The slope characteristics alone are considered in Figures 3-4. Graphs following the method suggested by J. O. Veatch have been drawn to show the relative proportions of slope, level upland, and level lowland in the types as well as to give an idea of

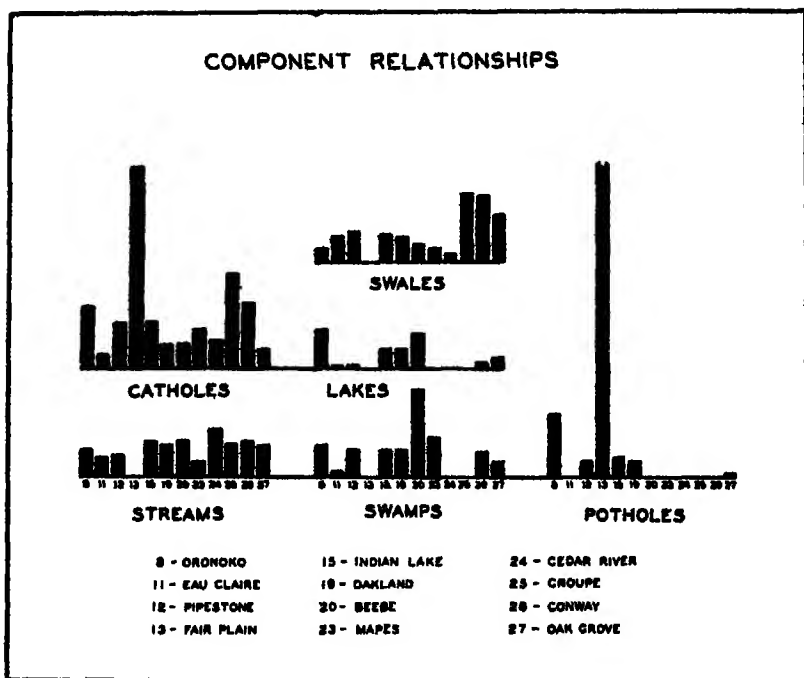


FIG 6

the steepness of slope<sup>2</sup> The flat part of each graph at the extreme left represents the proportion of lowland (0-3 percentage of slopes), and the flat part of the graphs at the extreme right shows the percentage of level upland. The slanting line indicates the character of the slope. Notice the predominance of steep slopes in the Oronoko in contrast to the short gentle slopes of the Eau Claire type (Fig 5). Lowland is a little more extensive in the Oronoko, but nearly all the Eau Claire type is in level upland. The large amount of lowland in the Beebe type is one of its most important characteristics, together with the fact that there is no upland.

Although the slopes in these illustrations differ greatly, it should be remembered that land types are based not on slope alone but on combinations of slopes and other qualities. To make this clearer,

<sup>2</sup> Veatch, J. O., "Graphic and Quantitative Comparisons of Land Types," *Journ. Am. Soc. Agro.*, 27 (No. 7): 505-510. 1935.

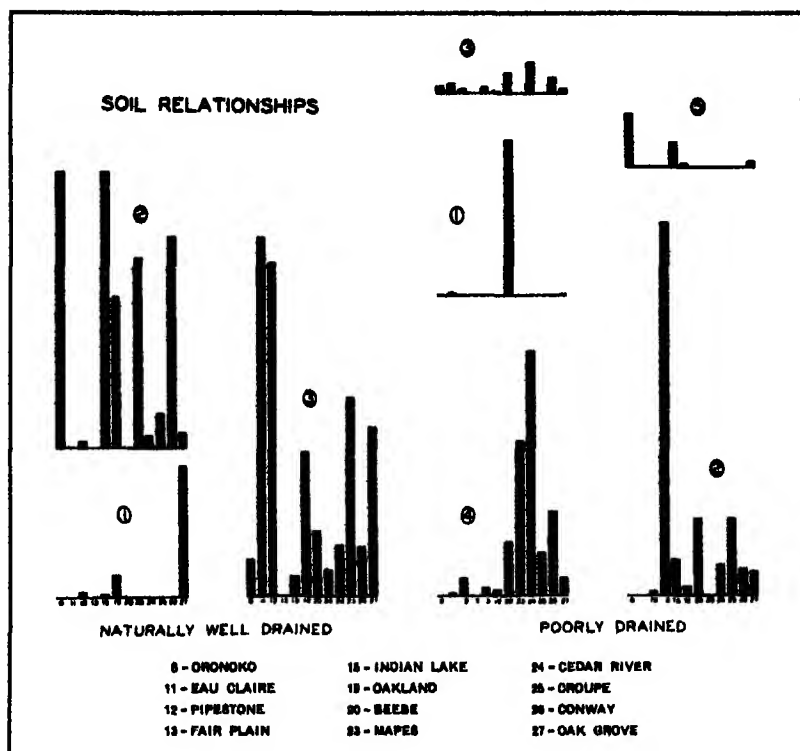


FIG 7

graphs were constructed from the data of Table I. The bar graphs in Figure 6 demonstrate the variability of occurrence of such land elements as streams, catholes, and potholes. In like manner Figure 7 illustrates the soil differences.

Land typing is recommended as a method of land classification to which other data may be related. It offers practical application to agricultural and county rural zoning programs. Social and public administrative agencies are looking more and more for such convenient classifications for use in their work.

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**PLATES I-II**

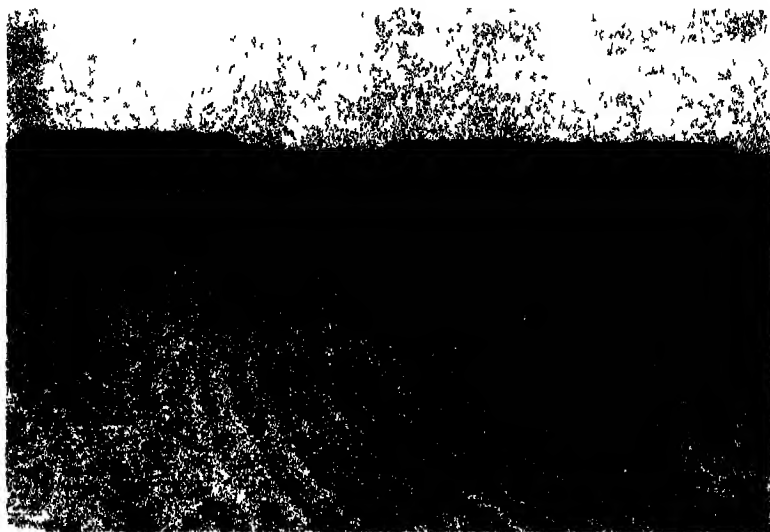


FIG. 1 A ploughed field in Eau Claire land type  
Howell Township, Section 18



FIG 2 Oronoko land type Putnam Township, Section 38





FIG 1 Compound gullies in Ononoko land type  
Putnam Township, Section 28



FIG 2 Beebe land type Ocoola Township, Section 34



# THE PROBLEM OF FOREIGN IMMIGRATION IN BRAZIL \*

PRESTON E JAMES

**T**O MANY North Americans not familiar with Brazilian problems the news that our huge southern neighbor had adopted a policy of immigration restriction came as a surprise. Here is a country with a territory larger than continental United States, exceeded only by the Soviet Union and China, containing a variety of known mineral resources, and having a larger proportion of the land habitable than any other political division of the earth of comparable size. And the population today is only about the same as that of Italy — forty-five million. The situation would be similar if the Italians alone possessed all of Europe outside the Scandinavian countries. Yet Brazil has adopted a policy of immigration restriction and control.

The complicated currents of ideas and economic pressures in a country as large as Brazil are not easily understood. Nor is understanding aided by the common tendency to oversimplify the situation by making reference to such political formulae as fascism, communism, and democracy — all concepts which obscure rather than illuminate the Brazilian picture. It is the purpose of this paper to outline briefly some of the social and political problems involved in Brazil's immigration policy as an essential part of the background of a geographical study of the patterns and possibilities of settlement in southeastern Brazil, for the study of the land with its human inhabitants is intimately bound up with these social and political ideas and problems.

## IMMIGRATION CONTROL

The policy of immigration control was first announced in 1934. This was one of the reforms instituted by the new government of

\* The field studies on which these observations are based were supported in part by grants-in-aid from the Social Science Research Council and from the Faculty Research Funds of the University of Michigan. The field work was done during the period from February to September, 1938.

Getulio Vargas, which came into power in 1930. In May of 1938 a new decree was issued, which was the result of a considerable and realistic study of the immigration problem. A quota system assigns each year a limit of two per cent of the number of people of any one nationality who entered Brazil between 1884 and 1933. There is a minimum quota, however, of 3,000, and there is a provision which permits the transfer of unused quotas or portions of quotas to other nationalities in accordance with bilateral immigration arrangements which may from time to time be worked out. The results of this are to restrict immigration from sources outside Europe and America and to provide for the selection and stimulation of desirable currents of migration.

The new decree also regulates the activities of foreigners after they reach Brazil. At least 80 per cent of each quota must be made up of agriculturists or of technicians for rural industries, and the members of these groups are not permitted to abandon their professions during the first four years after their arrival. Furthermore, in each colony established in the pioneer zones at least 30 per cent must be made up of people born in Brazil, and not more than 25 per cent may be composed of foreign people of any one nationality. Also, in the rural schools instruction must be given in Portuguese for certain parts of every day, and the direction of the schools must be in the hands of Brazilians.

The need for such a policy in a land where the outstanding social fact is the lack of man power must be considered carefully. When the advantages of parts of Brazil's huge territory become more widely known and when in the unpredictable future conditions in overcrowded Europe again reach a state in which people are permitted to migrate from areas of poverty to areas of greater opportunity, the growth of a considerable movement toward Brazil may be expected. One of the major arguments used in the United States in favor of our policy of immigration restriction was the protection of our population from too much dilution by elements which we thought could not readily be assimilated. To what extent is this argument valid in Brazil?

#### WHO ARE THE BRAZILIANS?

In order to understand the composition of the Brazilian people we must attempt to form a picture of the remarkable diversity of the

elements which have entered it.<sup>1</sup> By 1822, when Brazil became independent of Portugal, its population was already composed of many different ingredients. The historian will explain that before the Portuguese colonizers crossed the ocean they had absorbed at least five or six major elements, ranging from Aryan Christians from the north to Moorish Islamites from Africa and including not a little of the Semitic. In the New World these people intermarried freely with the native Indians, whose blood forms a considerable part of the present Brazilian "race." Brazil, also, was one of the chief importers of Negro slaves, and the equally free intermarriage with these people has darkened the Brazilian skin from the Amazon to Rio de Janeiro.<sup>2</sup> In the features of the Brazilian people today the most extraordinary combinations of all these elements can be identified.<sup>3</sup>

In addition to all this, since 1822, some five million immigrants have entered the country. Most of this invasion has come since 1888, when slavery was abolished. Among the numbers of immigrants Italians stand first and Portuguese second. Farther down the scale, but still in important numbers, are Spaniards, Japanese, Germans, Russians, Poles, Austrians, Turks, and Lithuanians.<sup>4</sup>

More than half of all these immigrants went to one state. Since the middle of the last century São Paulo has been furnishing the chief economic product of Brazil, coffee, and has had the largest influx of foreigners.<sup>5</sup> As early as 1847 the advantages of free labor over slaves were recognized in this progressive state, and one plantation owner imported, with government aid, eighty families of Germans to work as tenants on his coffee lands. Between 1890 and 1900 an amazing number of Italians came to São Paulo, but with the first coffee crisis and with the restriction of emigration from Italy this wave was

<sup>1</sup> See the excellent general summaries of these facts in R. Nash, *The Conquest of Brazil* (New York, 1926); and J. F. Normano, *Brazil, a Study in Economic Types* (Chapel Hill [North Carolina], 1935).

<sup>2</sup> Ramos, A., *O negro brasileiro* (Rio de Janeiro, 1934).

<sup>3</sup> A book of outstanding importance on the fundamental characteristics of the Brazilians is S. Buarque de Hollanda, *Raízes do Brasil* (Rio de Janeiro, 1936).

<sup>4</sup> Maurette, F., and Siewers, E., "Immigration and Settlement in Brazil, Argentina, and Uruguay," *Int. Labour Rev.* 35, 215-247, 1937, and "Cincoento anos de imigração," *Boi do min. de trabalho, industria e commercio*, Abril, 1937, pp. 301-314.

<sup>5</sup> Ellis Junior, A., *Populações Paulistas* (São Paulo, 1934); and "Movimento migratorio no estado de São Paulo," *Boi da dir. de terras, colonias e imigração*, 1:31-158, 1937.



brought to a halt about 1902 Immigration, largely from Italy, was reaching a new peak when the World War shut off the supply at its source<sup>6</sup> After the War the number of Italians decreased sharply, but the number of Japanese has greatly increased In 1934 the Japanese had reached second place, exceeded only by the Portuguese<sup>7</sup> Since the Great Depression the current of immigration has remained well below the peak figures of 1895, 1913, and 1929

#### LAND SETTLEMENT — "FAZENDAS"

There are several reasons for Brazil's failure to attract a larger number of immigrants Before 1888 the position of free labor was precarious, especially in the regions of the great coffee or sugar plantations, known as *fazendas* But even after 1888 the position of the tenant laborer on the big plantations was not a very pleasant one We must remember that, in spite of the many romantic pioneer stories, most of those who came to the Americas from Europe were activated by motives of economic gain, few by the ideal of liberty and the desire to create a new home in the wilderness The tenants on the coffee plantations had neither permanent homes nor opportunity for the acquisition of wealth The handful of conspicuous exceptions were scarcely enough to lure the multitude forward In spite of a chronic shortage of labor, even today the level of wages has not risen very greatly<sup>8</sup>

Furthermore, the history of rural land settlement in Brazil is one of shifting, temporary cultivation — a record of the destructive exploitation of soils, water, and wood for immediate gain To a much greater degree than the Spaniards in the other parts of Latin America the Portuguese were preoccupied with commercial activities<sup>9</sup> They did relatively little to implant their culture in the New World, as the Spaniards did<sup>10</sup> Brazilian economic history records a succession of bonanza products, each dominating the life of a period and

<sup>6</sup> Rodrigues de Mello, A, "Imigração e colonização," *Geografia*, 1 25-49 1935

<sup>7</sup> Lehmann, E, "Zur Kulturgeographie der japanischen Siedlungen in Brasilien," *Wiss Veröffentlich des Museums für Länderkunde zu Leipzig*, N 8, No 3 207-216 1935

<sup>8</sup> Maurette, F, *Some Social Aspects of Present and Future Economic Development in Brazil*, Int Labour Office, Studies and Reports, Ser B, No 25 Geneva, 1937

<sup>9</sup> Buarque de Hollanda, *op cit*, p 66

<sup>10</sup> Calmon, P, *História da civilização brasileira* São Paulo, 1933.

each located in a different geographic region. First it was the sugar in the northeast,<sup>11</sup> then it was the gold north of Rio de Janeiro, which gave the first real start to that city,<sup>12</sup> then it was coffee in São Paulo,<sup>13</sup> with a brief but dazzling interlude of rubber in the Amazon. Since 1930 cotton has been rising like a skyrocket; and during 1938 a new source of wealth has been the cultivation of oranges. Moreover, in the last decade speculative profits have been made with increasing ease in the big cities — in office buildings, apartments, and urban industries, the owners of the coffee *fazendas* have been shifting to the cities, leaving the cotton frontier largely to small landowners.<sup>14</sup> But the same process of exploitation and abandonment has been continued.<sup>15</sup> The pioneer settlement proceeds like a wave across the country, clearing the forest in front but abandoning the older agricultural zones behind.<sup>16</sup> The Brazilian frontier remains even now a hollow one. As long as such conditions prevail there can be no secure economic values, not even in the cities.

#### THE COLONIES

The system of big plantations, however, did not cover all of Brazil.<sup>17</sup> Between the coffee plantations of São Paulo and the cattle estates of the grassland regions of the south the intermediate woodlands, much of them unsuited to coffee or sugar because of frosts, were the chief zone of European colonization. Here a relatively permanent settlement of small farmers has developed. Here are located the colonies of Germans, Poles, Italians, and Japanese, in groups undiluted by mixture with other nationalities which the Brazilians fear cannot be assimilated.

In 1910 a Brazilian sociologist wrote that the Portuguese who formed the basis of the population of the southern part of Brazil had

<sup>11</sup> Freyre, G., *Casa-Grande e Senzala*. Rio de Janeiro, 1933; *Sobrados e Mucambos*. São Paulo, 1936, and *Nordeste*. Rio de Janeiro, 1937.

<sup>12</sup> James, P. E., "Rio de Janeiro and São Paulo," *Geog. Rev.*, 23, 271-298, 1933.

<sup>13</sup> James, P. E., "The Coffee Lands of Southeastern Brazil," *Geog. Rev.*, 22, 225-244, 1932.

<sup>14</sup> Monbeig, P., "Les Zones pionnières de l'état de São Paulo," *Ann. d'histoire écon. et sociale*, 9, 243-365, 1937.

<sup>15</sup> Vianna, O., *Populações meridionais do Brasil*, Fourth edition. São Paulo, 1938.

<sup>16</sup> James, P. E., "The Changing Patterns of Population in São Paulo State, Brazil," *Geog. Rev.*, 28, 353-362, 1938.

<sup>17</sup> Denis, P., *Le Brésil au XX<sup>e</sup> siècle*. Paris, 1909.

great powers of assimilation, which only those foreigners occupying extremely isolated positions could resist<sup>18</sup> The isolation of some of these "pure" colonies has been so great, however, that they have remained to this day conspicuously foreign<sup>19</sup>

The German settlements around Blumenau in the state of Santa Catarina may serve as an example<sup>20</sup> In 1850 a German doctor, realizing the value of this part of Brazil as a place for European farm colonists, gathered together a number of families from Pomerania. These people were fleeing from oppression and seeking to create a new home in a land of freedom. Compared with the temporary, camplike houses of the Brazilians and the prevailing haphazard exploitive agriculture, these Pomeranian settlements form a most remarkable contrast. The houses are substantial and comfortable; the agriculture is closely adjusted to the conditions of the land, good all-weather roads connect the settlements with a port; and there is a sufficient number of schools, so that illiteracy is much reduced. This Blumenau colony was later the source of other similar colonies near by, each strongly marked with the German way of living. These people freely accept the Brazilian flag and the Portuguese language, but in the absence of Brazilian schools and teachers they founded their own schools and imported their teachers from Germany<sup>21</sup> They remain unassimilated chiefly in the sense that they have refused to change their system of permanent land settlement and the relatively high standard of living this implies for the form of land exploitation and temporary settlement prevailing among the Brazilians<sup>22</sup>

A large number of colonies similar to Blumenau were established between 1850 and 1914 in the four states of São Paulo,<sup>23</sup> Paraná,<sup>24</sup>

<sup>18</sup> Delgado de Carvalho, C. M., *Le Brésil méridional*, p. 267. Paris, 1910.

<sup>19</sup> Cameron, C. R., "Colonization of Immigrants in Brazil," *Monthly Labor Rev.*, 33: 784-794. 1931.

<sup>20</sup> Endress, S., *Blumenau. Werden und Wesen einer deutschbrasilianischen Landschaft*, in "Schriften des deutschen Ausland-Instituts Stuttgart," N. R., Band 5. Ohringen, 1938.

<sup>21</sup> Grothe, H., *Im Kamp und Urwald Südbrasilien*. Berlin, 1936.

<sup>22</sup> Pinho, W., "Fixação dos imigrantes e assimilação do imigrante estrangeiro," *Rev. Soc. de geog. do Rio de Janeiro*, 41: 133-151. 1935.

<sup>23</sup> Paula Lopes, R., "Land Settlement in Brazil," *Int. Labour Rev.*, 33: 152-184. 1936.

<sup>24</sup> Maack, R., "Die neuerschlossenen Siedlungsgebiete und Siedlungen im Staate Paraná," *Iber Amer. Archiv*, 11: 208-242. 1937.

Santa Catarina,<sup>22</sup> and Rio Grande do Sul.<sup>23</sup> A few were federal or state colonies, but many more were developed by private land companies. Some have prospered, some have declined. The German colonies have multiplied because the second generation usually moves on to new lands, but the Italians, who prefer to maintain their families united, have not increased. It must be said, moreover, that in general the most successful colonies seem to be those composed of one nationality.

The conditions and characteristics of immigration changed radically after the War. Relatively few people in the modern world are willing to cross the ocean to win a subsistence living in a pioneer zone. Most of the colonists prefer to seek their fortunes in the big cities, only the hope of speculative gain with a one-crop system can lure them temporarily to the frontier areas. Finding farm immigrants who wish to remain permanently on the land becomes a matter of greater and greater difficulty. This would be the case even in the rich Corn Belt lands of the United States if this region were today in search of agricultural settlers.

Another important change in the attitude of the immigrants, especially in the last decade, is produced by the rise of the spirit of aggressive nationalism. Few Europeans today, notably few of those from Italy and Germany, are willing to accept another flag permanently. When such people migrate they are apt to carry with them an ideology that makes them virtually impervious to assimilation. We could only guess at the success of assimilation in the second generation.

The Germans, for example, who have continued to furnish each year a small but steady stream of new agricultural pioneers to the state of Paraná, are filled with that stuffy-eyed conviction of racial and cultural superiority which they have adopted as a defense against the difficulties of reconstruction in war-torn Europe. Their code is a form of religious inspiration that gives them extraordinary perseverance in the face of obstacles and places them among the world's best pioneers. Tenaciously they hold to the German way of life, by

<sup>22</sup> Maack, R., "Geographische und geologische Forschungen in Santa Catharina (Brasilien)," *Zeit. der Gesell. für Erdkunde zu Berlin*, Ergänzungsheft V, 1937.

<sup>23</sup> Oberacker, K., *Die volkspolitische Lage des Deutschtums in Rio Grande do Sul (Südbrasilien)*, in "Schriften des Instituts für Grenz- und Auslandsdeutschtum an der Universität Marburg," No. 9. Jena, 1936.

brute force subduing the wilderness and creating civilized communities and insisting on education for their children. Unfortunately their contacts with the Brazilians come precisely at those points where Brazilian civilization is weakest, namely, the rural settlements. And now the new immigration law demands that instruction be given in Portuguese and that schools be directed by Brazilians. But Brazilian teachers and directors cannot be found in sufficient numbers, for few educated Brazilians are willing to accept posts in rural services. As a result hundreds of German schools stay closed.

The Japanese colonies have also remained distinctly foreign. Most of them are recent, a large number having been established since the World War as a result of activities of a Japanese land company. By present estimates there are between 160,000 and 200,000 Japanese in Brazil. The majority of them are in São Paulo state, especially on the cotton frontier, where they have settled large areas in purely Japanese colonies.<sup>27</sup> As the head of one land company told me, "The Japanese are our best settlers. They make a great fuss before they decide to purchase a piece of land. They send the soil away for analysis, and come to examine every aspect of the proposed purchase. But when they make up their minds and have moved onto the property, it is the last I see of them. They work harder than any one else." And, in this world of would-be city dwellers, over 98 per cent of them are farmers.<sup>28</sup> Like the Germans, they build substantial houses and insist on schools for their children.

These Germans and Japanese, along with some other nationalities for one reason or another more easily assimilated, have been the chief sources of permanent agricultural settlers in southern Brazil. Yet it is these people especially who will be restricted by the new law — the Japanese, because their quota will be only a little over 3,000 and many more would like to come; the Germans, because they cannot accept life in a community which is only 25 per cent German and which is not provided with schools.

<sup>27</sup> Domaniewski, Z., "Japanische Einwanderung in Brasilien," *Zeit. für Geopolitik*, 14 25-30 1937.

<sup>28</sup> Maurette, p 88 of work cited in note 8.

## THE PROBLEM OF THE FOREIGNERS

The road toward the permanent solution of these difficulties is not easy to discern. The only way to remedy the weakness of Brazil, its lack of man power, is to develop a vastly increased foreign immigration. No Brazilian frontier can be anything but hollow unless, like our own westward movement, it is supported by a torrent of foreigners.<sup>29</sup> Without such a torrent the traditional system of temporary exploitation must be continued. Yet the Brazilians would not only have difficulty in finding a sufficient source of agricultural immigrants in the modern world, but would have reason to fear the results of such a vast influx of foreigners imbued with nationalistic ideas derived from a troubled Europe.

It is difficult to estimate the extent to which fear of foreign influences in Brazil is warranted. A very great deal of hysteria surrounds this problem. No help toward a better understanding of the realities is yielded by the common habit, in Brazil as well as outside, of lumping together everything of which disapproval is implied under the terms "communism" or "fascism." These words stand for very complicated movements, which, taken out of the social and economic environment in which they originated, become something entirely different. It is the old story of the confusion of ideas and words. To be sure, the *integralista* movement, which in May, 1938, led to an abortive revolution against the *Estado Novo* of Getulio Vargas, adopted a number of ideas and terms from Europe, and there was some attempt on the part of the Brazilian government to claim actual German participation. Vargas himself in the new government proclaimed in November, 1937, which eliminates congresses, elections, and even political parties,<sup>30</sup> uses many phrases of a familiar European origin.<sup>31</sup> In July, 1938, he said to the workers in São Paulo "The *Estado Novo* does not recognize individual rights against the collective good." But such words and ideas taken out of

<sup>29</sup> Compare the estimate of population capacity in terms of the physical quality of the land presented in F. Freise, "Brasiliens Bevölkerungskapazität," *Peterm. Mitt.*, 82, 143-147, 1936.

<sup>30</sup> Arrais, M., *O estado novo e suas diretrizes*. Rio de Janeiro, 1938.

<sup>31</sup> Careful summaries of the political and economic development of Brazil as a background of the present political situation are to be found in H. Vianna, *Formação Brasileira*. Rio de Janeiro, 1935, and J. M. Belo, *Panorama do Brasil*. Rio de Janeiro, 1936.

their European context suffer profound changes of meaning. When addressed to the people of a densely populated country, struggling with problems of inadequate resources and accepting collective discipline with almost religious fervor, such words arouse a certain series of emotions, but, transferred to a country scantily populated, rich in undeveloped resources, and with a population notably individualistic in character, the emotions evoked are of an entirely different sort. Political movements such as the *integralista* revolt are, in the writer's opinion, traditional movements of opposition to the régime in power, they are not based on fundamental differences of ideology, but are only decked out superficially with an array of borrowed words and phrases. It would seem to be a serious error to give these movements other significance.

The European attitude toward Brazil, however, cannot so easily be set aside. Observation of the German colonists in southern Brazil, for instance, does not indicate that these people think of themselves as the spearhead of an invasion. On the other hand, it is not at all certain that some people in Germany do not consider them such. One cannot overlook the definite fear which has developed in the minds of many inhabitants of the American continents regarding the attitude of some of the European states toward the potential wealth and the vast areas of land suitable for settlement on this side of the Atlantic. In some measure these fears have been aroused by the bombastic pronouncements of European statesmen, and in some measure they have been built up by a rather obvious sort of propaganda originating in the necessities of domestic politics. Fear of actual armed invasion is absurd unless the combined navies of several outstanding powers in Europe and elsewhere were in some strange manner removed or reduced. But this is not the case, nor is it likely to be. To employ military leaders to give due consideration to these possibilities and to provide plans for defense is right and proper. But to give too much prominence to such fears in shaping the present policies is to become a victim of that hysterical sense of uncertainty which is so important a cause of the exaggerated nationalism of this insane period.

One thing stands out clearly. The possibilities of settlement in the pioneer zones of Brazil cannot be understood or predicted from a study of the physical quality of the land alone. People make a land habitable. And the kind of people who may desire to undertake the

settlement of Brazil's pioneer zones cannot at present be identified, nor can we know what political and social ideas or what technical abilities they will bring with them. Beyond a program of mapping, analysis of the physical quality of the land, interpretation of the present patterns of settlement and of past experience on different kinds of land, the prediction of future population capacity involves too many unknown factors to be profitable.

UNIVERSITY OF MICHIGAN





## KATAHDIN IRON WORKS, MAINE. A STUDY IN POPULATION DISTRIBUTION \*

CLYDE F KOHN

**K**ATAHDIN IRON WORKS, once the scene of the active exploitation of a mineral resource, is today a deserted village in the forested area of central Maine. An unimproved dirt road is its only connection with Brownville Junction (Fig 1), the nearest market center. The village, which was preceded by a brief unsuccessful agricultural settlement in the region earlier in the century, really came into being with the development of iron mining in 1843, and its population immediately declined in 1888, when this generative force proved no longer profitable.

Population curves may be constructed which, when read in the light of local history, help one to understand population distributions in small areas. The curve for Katahdin Iron Works (Fig 2) shows four periods in its history, with a minor peak in 1850 and a major one in 1880. Each of these peaks is followed by a great decline of population — that of 1850 by a removal of all the people from the area and that of 1880 by a decline of 60.7 per cent. The closing of the mine in 1888 and the accompanying decrease in population cannot be ignored in a study of settlement in Maine. It is the purpose of this paper to analyze the development of iron mining at Katahdin Iron Works during the nineteenth century and to note its effect on the present distribution of population in the area.

The village is on the west branch of Pleasant River (Fig 3), the narrow, steep-banked outlet of Silver Lake. In this part of Maine rejuvenated streams have dissected an old upland surface,<sup>1</sup> and a few intruded masses of igneous rock rise three hundred to four hundred feet above the general level of the region. Ore Mountain,

\* The field studies on which these observations are based were supported by a predoctoral fellowship from the Horace H. Rackham School of Graduate Studies, University of Michigan. The field work was done during the summer of 1938.

<sup>1</sup> Toppan, F. W., "The Physiography of Maine," *Journal of Geology*, 43: 81, 1935.

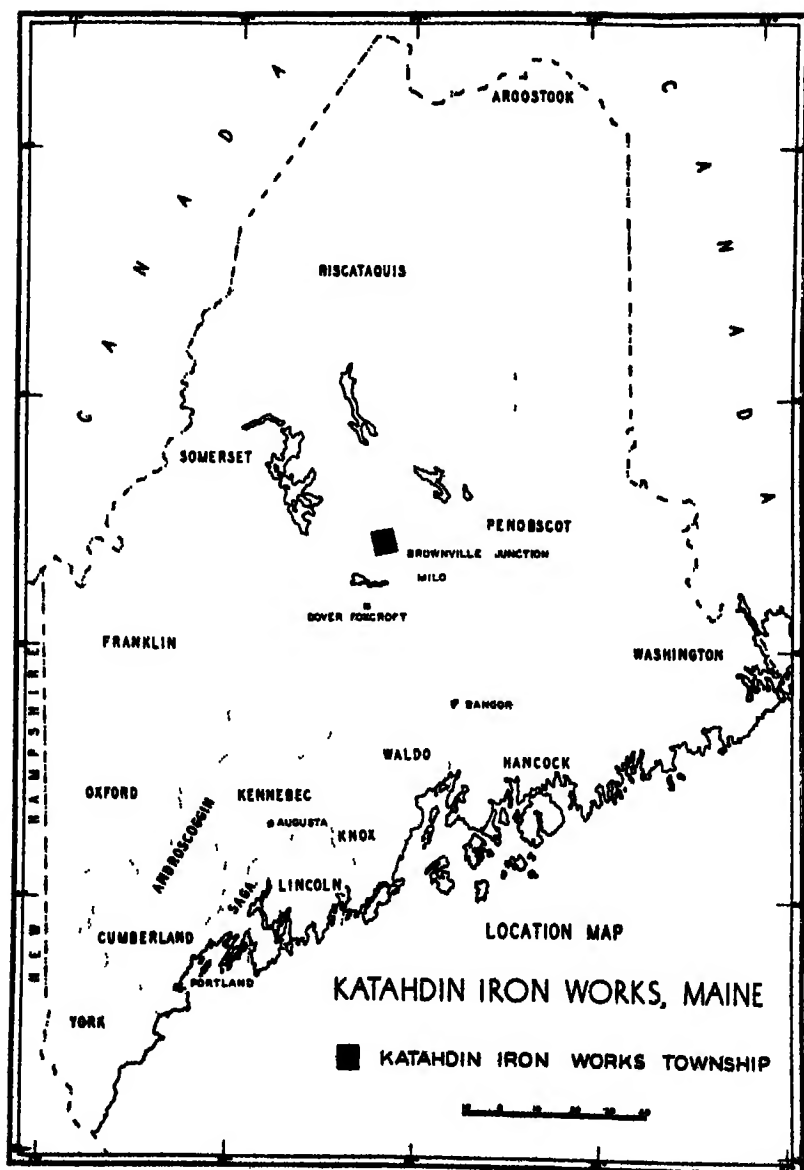


Fig 1

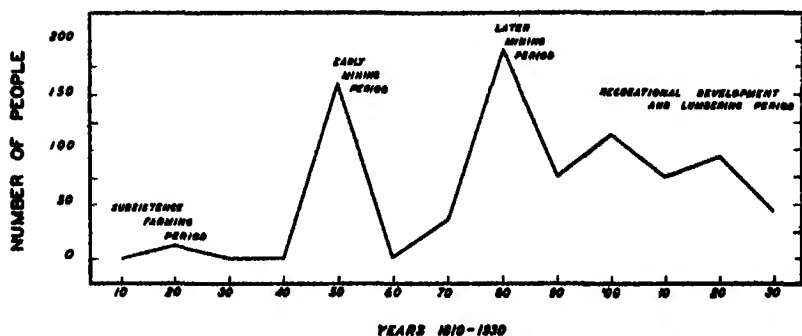


FIG 2. Population graph of Katahdin Iron Works Township

lying to the west of the village, is one of these masses of rock. It is extraordinarily rich in pyrrhotite.

#### FIRST SETTLEMENT OF THE TOWNSHIP

In 1814 the intervals northwest of Silver Lake were cleared and settled (Fig 4).<sup>1</sup> They were connected with the village of Sebec by a road through Barnard that has long been abandoned. The census for 1820 lists twelve persons as living in the township later known as the Katahdin Iron Works, but in the following year they exchanged their land for farms in Brownville. Since then no families have dwelt on these intervals. There was no one in the township in 1830 or 1840.

#### SETTLEMENT BASED ON MINING DEVELOPMENT

The second period in the history of Katahdin Iron Works began with the discovery of iron ore in the township by Moses Greenleaf,<sup>2</sup> onetime resident manager and co-owner of Williamsburg, but now remembered as Maine's first map maker. He learned, through the translation of Indian words, that Mun-na-lam-mon-un-gun, the name for the west branch of Pleasant River, meant "very fine paint" or "place where [it] was found." This led him to the discovery of the iron deposit. His efforts to influence the legislature at Portland to develop the property in order to stimulate settlement in the interior of Maine were, however, futile.

<sup>1</sup> Loring, Rev. A., *History of Piscataquis County, Maine* (Portland, Maine, 1880), pp. 220-223.

<sup>2</sup> Smith, Edgar Crosby, *Moses Greenleaf, Maine's First Map-Maker*. Bangor, 1902.

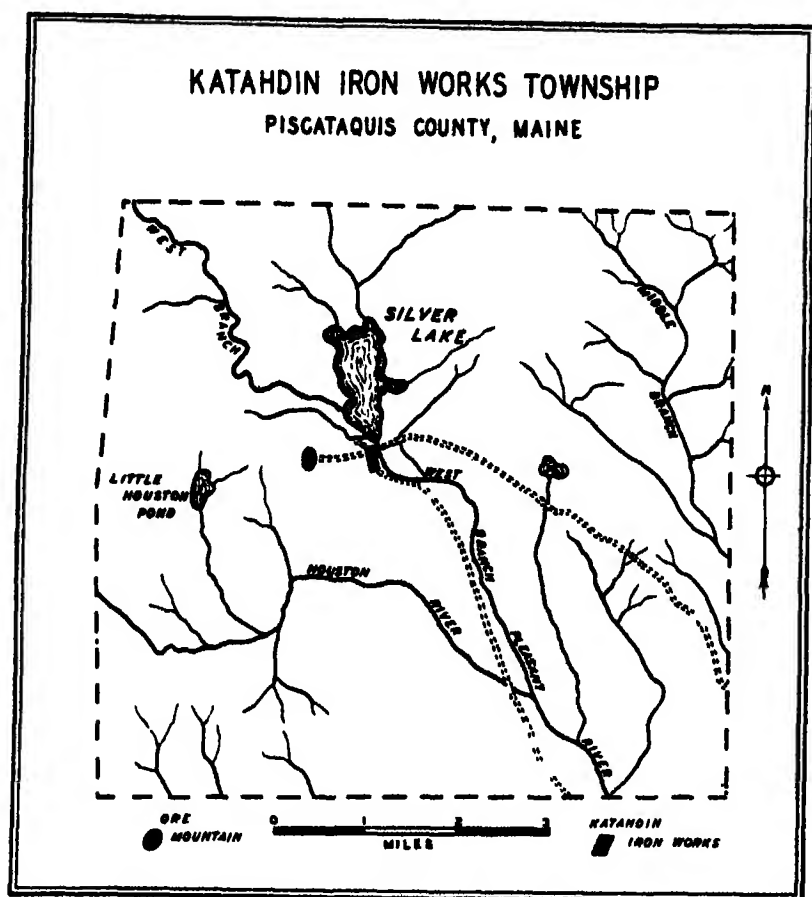


FIG 3 Drainage map of Katahdin Iron Works Township Pleasant River is a branch of the Piscataquis River, a western tributary of the Penobscot River

It was not until 1843 that the mining of ore was begun by Edward Smith, of Bangor<sup>4</sup> In 1845 he sold the property to David Pingree and Company, of Salem, Massachusetts This company carried on the work until 1856, when the hauling of the ore by ox team to Bangor, a distance of approximately sixty miles, proved too expensive, and the furnaces were abandoned In this period a hotel and several houses were built to accommodate the workmen. For six or eight

<sup>4</sup> Loring, *op cit.*, p 221

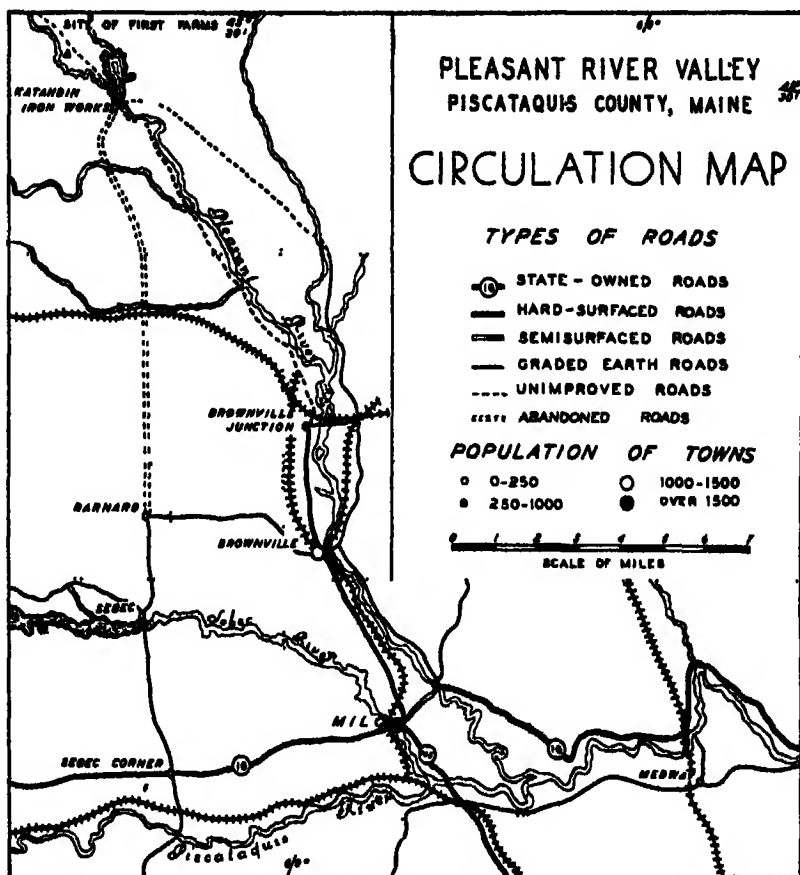


FIG 4

Highway 16 connects Milo with Dover-Foxcroft to the west,  
Highway 155 connects Milo and Bangor .

years all were vacant except one dwelling and the hotel, which was kept open to entertain lumbermen, explorers, and visitors. No inhabitants were recorded in 1860. With the closing of the mine the frontier of settlement had quickly retreated southward.

Hinkley and Egerly, of Bangor, the creditors of Pingree and Company,<sup>5</sup> next undertook to extract the ore. Because of the de-

<sup>5</sup> A box of records of this company that cover the affairs of the concern com-

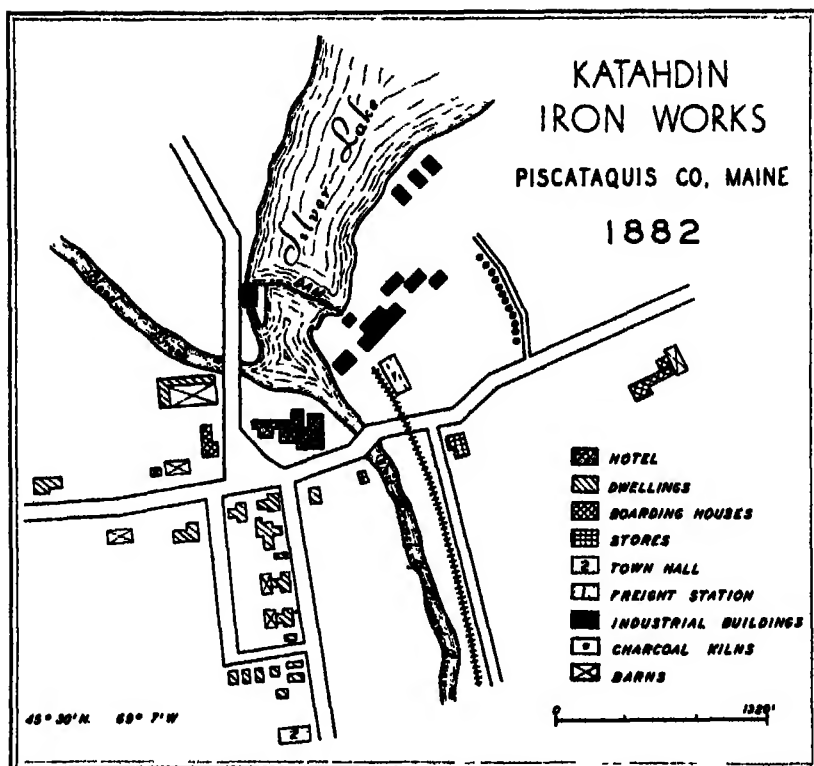


FIG 5

mand for iron during the Civil War the output at Katahdin Iron Works increased steadily. In 1869 the Bangor and Piscataquis Railroad reached Milo, and the long, expensive haul by team to

pletely for the years 1845-63, with scattered items for 1832-69, are in the possession of Mr. George T. Carlisle, Jr., president of the Piscataquis Iron Company, Bangor. There are also complete treasurer's records for this period, a copy of the act of incorporation, and a record of the stockholders' meetings, 1846-50, but there is no record of individual holdings. The papers include the following: paid bills, bills of lading, accounts with haulers, vouchers, furnace records, checks, trustees' writs, letters between officials of the company and others addressed to David Pingree. There are an individual record of business done by one Coe and an account of transfer of stock in his favor. Inventories made in 1853 and 1857 and a survey made May 11, 1846, by Charles Jackson, are also available.

Bangor was no longer necessary. In 1882 (Fig 5<sup>6</sup>), in order to improve further the transportation facilities, the Katahdin Iron Works branch of the railroad was built.<sup>7</sup>

About this time the Iron Works had become noted as the source of some of the best tool steel in America. About one hundred men were employed at the mine the year round. This number was increased to three hundred or more during the winter, when the year's supply of wood for making charcoal was cut and hauled to the furnace.

The village in the meantime had become a recreational center as well as a mining town. Located at the outlet of Silver Lake and among the hills in the woods of the central upland of Maine, it attracted a number of summer guests because of its scenery as well as the opportunities it afforded for hunting and fishing.

The rate of growth of the village was not, however, to be maintained. Near the end of the century several economic factors began to discourage further development. From 1843 to 1890 the property had been worked as an iron mine by utilizing the oxidized part or "gossan"<sup>8</sup> at the surface and also the pyritic ore deposited from spring waters issuing along the hillsides. These deposits were practically exhausted by 1890. The large body of pyrrhotite<sup>9</sup> that remained was of a low grade (42-50 per cent iron) and contained much sulphur (26-35 per cent). This made it necessary to put the ore through a special process of desulphurization before it could be smelted. Charcoal smelting also increased the costs of production. Furthermore, competition was encountered from Michigan and other parts of the West, where cheaper ore was available nearer the markets. The business at Katahdin consequently dwindled and was finally abandoned. The last iron was shipped about 1890.<sup>10</sup>

The closing of the mines in the township brought about an im-

<sup>6</sup> Redrawn from *Atlas of Piscataquis County, Maine* (Houlton and Dover, Maine, George N. Colby and Company, 1882), p. 64.

<sup>7</sup> *The Twenty-first Anniversary of the Bangor and Aroostook Railroad*. Bangor, Maine, 1912.

<sup>8</sup> Bastin, E. S., "Large Pyrrhotite Deposits in Maine," *Engineering and Mining Journal*, 104, 758-759, 1917.

<sup>9</sup> Philbrick, Shailer S., "The Contact Metamorphism of the Onawa Pluton, Piscataquis County, Maine," *American Journal of Science*, Fifth Series, 31 (1936) 9-10.

<sup>10</sup> Some of the information included here was given to the author by Mr. George Knowlton, Postmaster, Katahdin Iron Works, Maine.



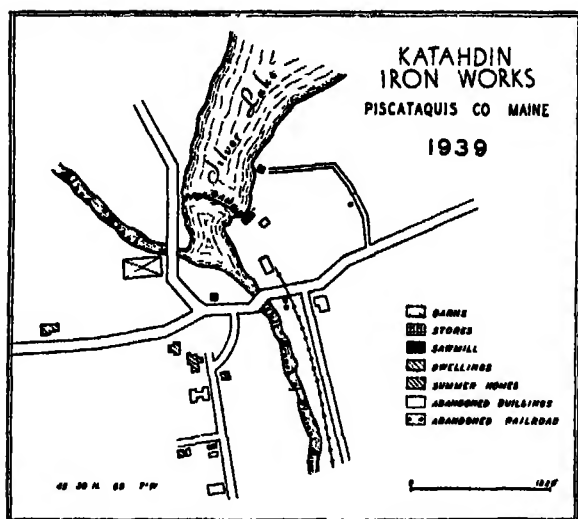


FIG 6

Note the number of abandoned buildings

mediate decline in population. Houses were vacated (Fig 6), the furnace was allowed to fall into disrepair, and the hotel, destroyed by fire, was never rebuilt. The Katahdin Iron Works branch of the Bangor and Aroostook Railroad was discontinued from Brownville Junction in June, 1922. In 1936 the tracks were taken up. Today the right-of-way is used as a private road into the Iron Works. Only the remnants of the iron furnace, a rock pile, and one large round-topped charcoal kiln are left to tell the story of the industry that had attracted so many inhabitants to the area.

The population curve (Fig 2) indicates that the settlement entered another cycle in 1890. However, seasonal lumbering and recreational development rather than permanent settlement characterize this later period. Many of the old houses have been turned into summer homes, and new cabins have been built along the banks of Silver Lake, but in 1930 only forty-two persons resided in the township.

#### CONCLUSION

The four periods of settlement shown by the curve of population may be characterized as follows. the first, as a subsistence agricul-

tural invasion of the wilderness from 1814 to 1821; the second, as an early mining development from 1843 to 1860, the third, as a more intensive mining development from 1860 to 1890, and the fourth, as a seasonal lumbering and recreational development lasting from 1890 to the present day. It was in the second and third periods that the greatest number of people lived in the area. After the mine was abandoned the population retreated to the more densely settled areas to the south. Every now and then there are rumors concerning resumption of work at the mine for the purpose of obtaining sulphuric acid. Should this take place, there would begin another period in the history of the settlement of the township, based on the same natural resource that caused its growth in the nineteenth century.

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## A LAND-CLASSIFICATION SURVEY OF MAPLE RIVER TOWNSHIP, EMMET COUNTY, MICHIGAN

WILLIAM W LEWIS

**M**APLE RIVER TOWNSHIP, Emmet County, is an area with its main resource, timber, now depleted and many of its farms isolated and on unproductive soils (see Fig 1) It is a part of the cutover, submarginal region of Michigan in which attempts need to be made to change the land use The present uses are as follows (1) for crops such as wheat, oats, and rye, (2) for forage crops such as hay and clover; (3) for pasture, (4) for timber, and (5) for sites of towns In addition to these there are, of course, lands now idle (Fig 2)

A qualitative land-use classification restricts the best area to Sections 11 and 12 Section 16 and Sections 19 and 30 together follow in a scale of decreasing value In general, with these exceptions, the eastern and western parts of the township are ill suited to agriculture; a strip of the central sections, running north and south, is of fair quality

On Frank Leverett's map showing the surface formations of the Southern Peninsula of Michigan<sup>1</sup> the western half of the township is shown as land-laid moraines having a soil varying from very stony material to a heavy clay with few stones, whereas the eastern half is represented as sandy lake beds with a light soil

A detailed soil survey was made to break down this general classification. It is necessary to point out that designated qualities of soils hold true only for the northern part of the state The best soils in Maple River Township might be rated differently farther south in the state. The soils range in quality from Selkirk Silt Loam and Bergland Clay Loam, good soils if well drained, to Rubicon Sand, one of excessive drainage, or Rifle Peat, a swamp soil (Fig 3)

<sup>1</sup> Leverett, Frank, and Taylor, Frank B., "The Pleistocene of Indiana and Michigan and the History of the Great Lakes," *U S Geol. Surv. Mon* 53 1915



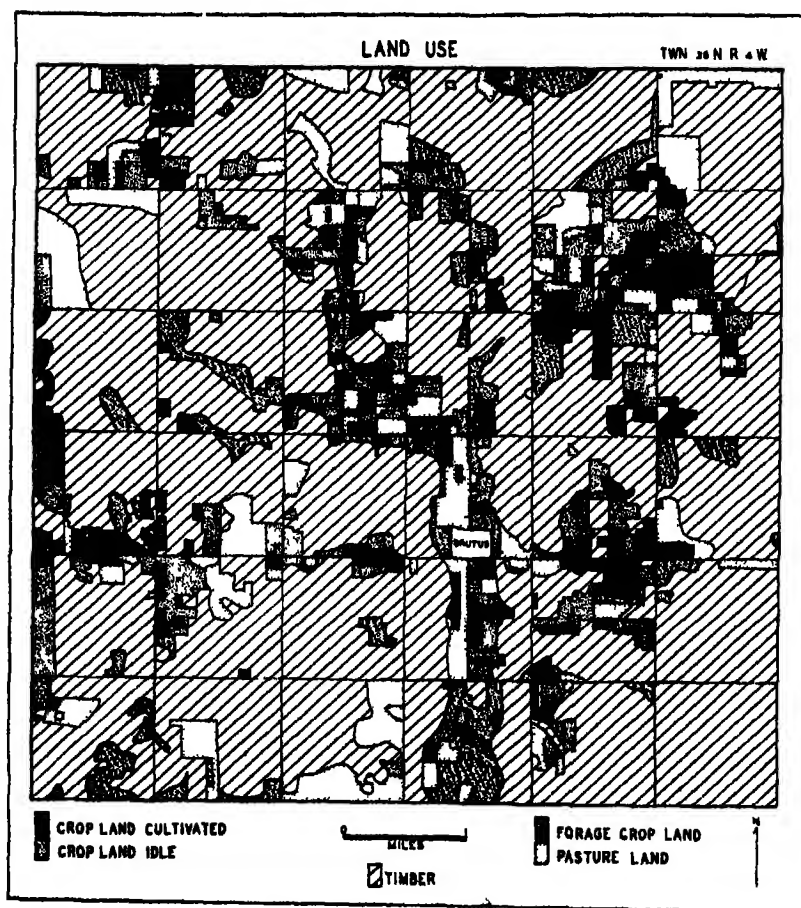


FIG 2. Present land-use patterns

Starting in the 'eighties, with the completion of the Pennsylvania railroad between Petoskey and Mackinaw City, lumbering operations were established within Maple River Township. Towns and mills sprang up along the railroad

Agriculture was early developed in the central eastern part of the township, and thence followed the lumber expansion westward. When lumbering fell off after 1910 agriculture likewise declined, with abandoned land appearing first in the northeastern and south-

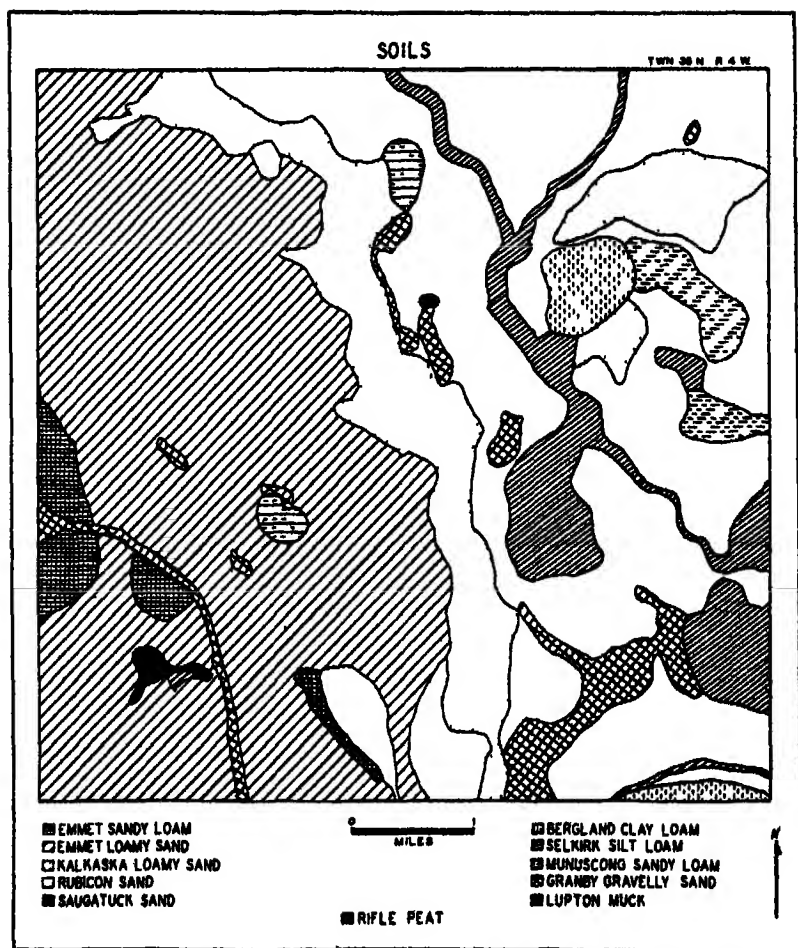


FIG 3 Distribution of soils

eastern sections Next to be deserted were lands near the mill towns Brutus and Pellston<sup>2</sup> After that failure and abandonment spread throughout the township<sup>3</sup> At the present time there are big tax-delinquent areas (Fig 5). A large number of these lands were bid to the state during the last tax sale (1938) Present con-

<sup>2</sup> Pellston is directly north of Brutus on the southern boundary of the adjacent township.

<sup>3</sup> Local information

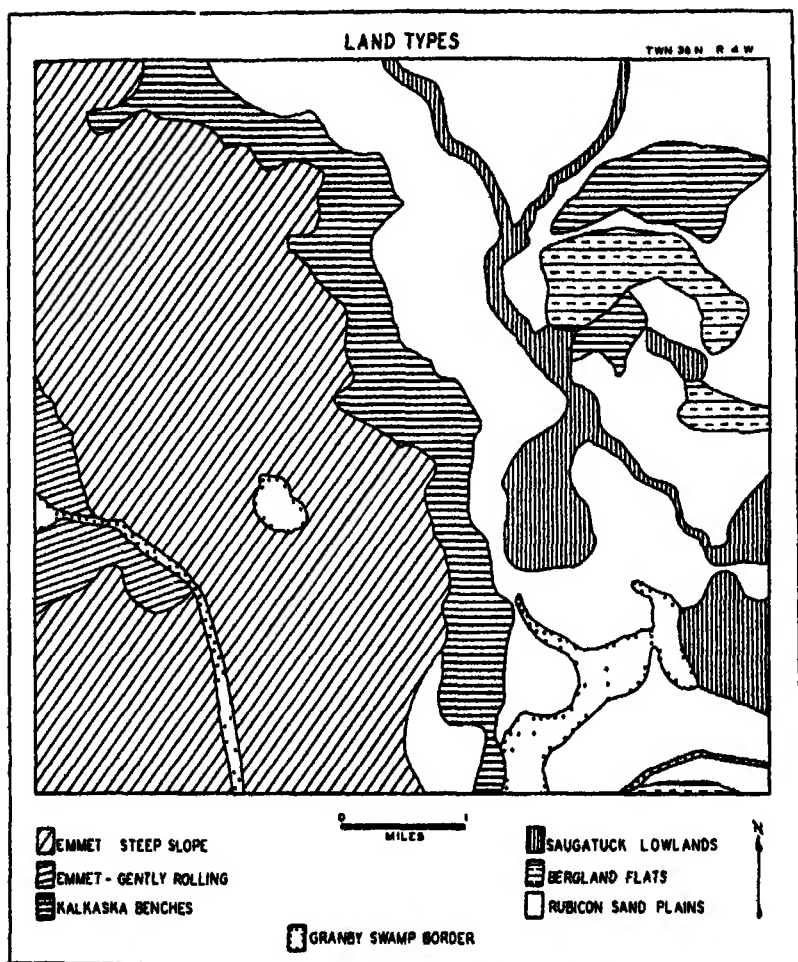


FIG 4 Distribution of land types

ditions indicate that many of the remaining tax-delinquent lands will soon be owned by the state. This general situation is strong evidence that a new system of land use is necessary

In 1937 the Emmet County Agricultural Planning Committee constructed, under the direction of the county agricultural agent at Petoskey, a land-classification map of the area. The committee



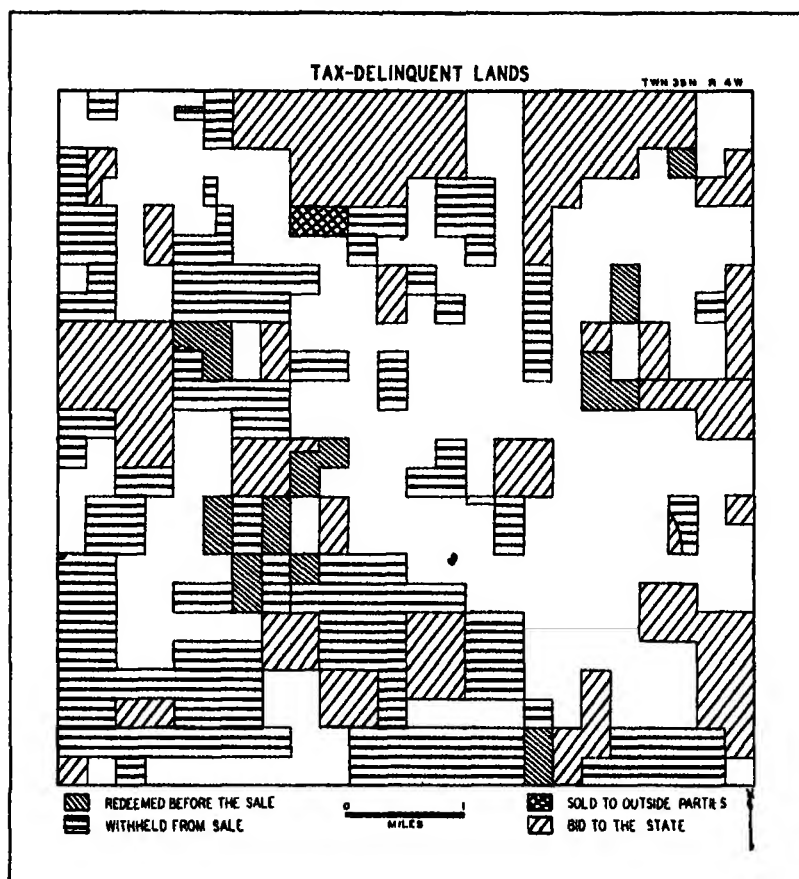


FIG 5 Disposal of tax-delinquent lands

was composed of groups of men from each township in the county, who classified their own districts. Personal prejudice shows up but slightly on the completed map.

Six categories were used and are represented on the map (Fig 6) by land ranging from black, or poor, to white, or the best. They are as follows. (1) areas which now contain farms, but which are not fit to farm and which should be put to some other use, (2) areas which are not now in farms and which should not be used for farms; (3) areas in which it is not certain that farming can be maintained;

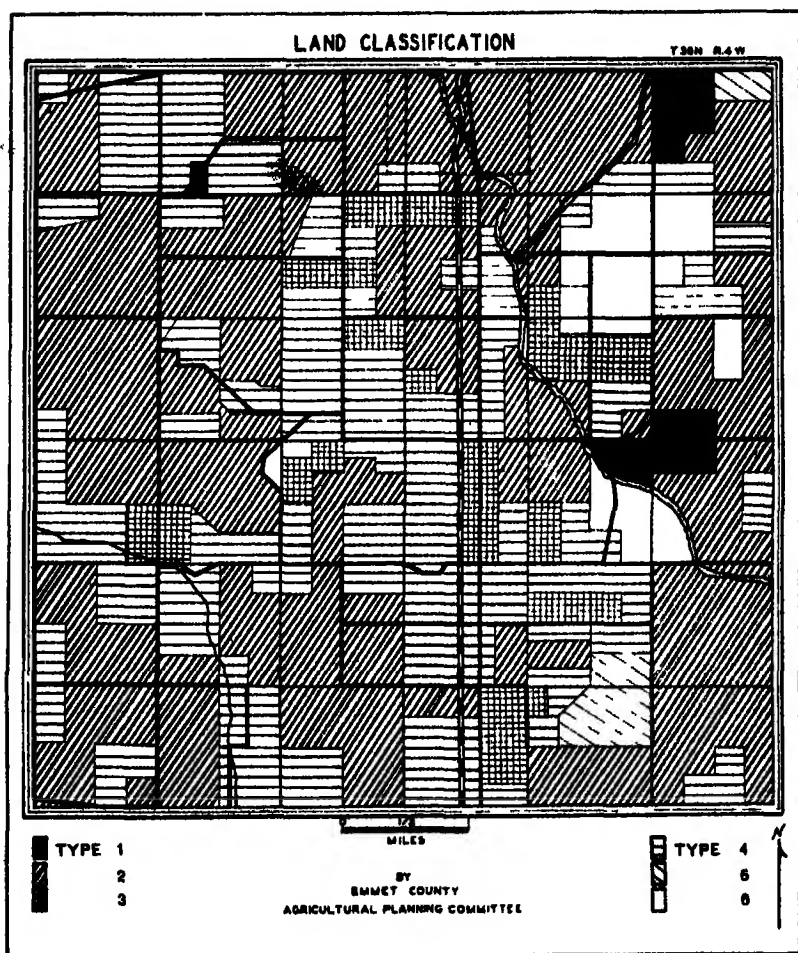


FIG 6

The value of the land for agricultural utilization is indicated by the shading, the black sections being the poorest farm land, the white, the best (the original order of the symbols is reversed here)

(4) areas which are not now in farms, but which may be suitable for agricultural development; (5) areas which are now in farms and are suited to farming, but in which important changes in types of farming or in sizes of farms are desirable, and (6) areas that are the best agri-

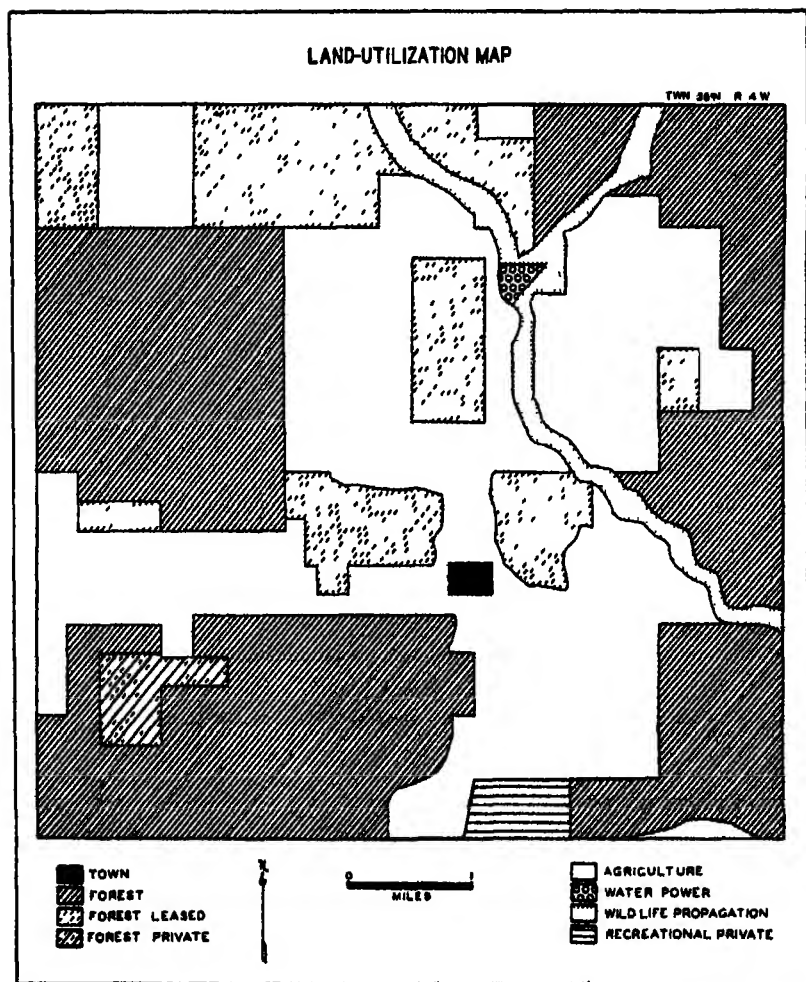


FIG 7 Suggested land utilization

culturally and are now in farms<sup>4</sup> A few of the criteria used in making the classification are poorness of soil, steepness of slope, isolation of individual farms from settlements so that the cost of roads and

<sup>4</sup> The six categories and criteria for making them were prepared jointly by the Resettlement Administration, the Agricultural Adjustment Administration, Extension, and the United States Department of Agriculture.

schools per family is unduly large, lack of dependable sources of nonfarm work, effort and expense of drainage, and consideration of changes in the type of farming which might require an excessive investment in land, buildings, equipment, and labor

Because the county classification suggests no use for nonagricultural lands it has been necessary to make a classification which does (Fig 7) In but a few places is there any strong disagreement between the maps concerning areas which should or should not be used for farming In nearly every instance tax delinquency was one of the reasons for making a change

The divisions of future use suggested here are agriculture, forest, recreation, wild-life propagation, water-power development, and town Their boundaries were established by a synthesis of maps showing cover and present use, soils, original vegetation, land types, tax assessments, ownership, tax-delinquent lands, house and road classification, and, finally, the county classification.

The forest land was divided into three groups (1) larger tracts, a great part of them now state-owned, which are to be given blanket protection common for state forests, (2) smaller isolated tracts, now likewise almost completely state-owned, which are to be leased to individuals for their subsistence; (3) an area privately owned

The wild-life propagation area is restricted to the Maple River and its banks Possibly this stream might be developed for fishing

The water-power development, which lies at the confluence of the eastern and western branches of the Maple River, consists of a dam and a hydroelectric plant It is the property of the Michigan Public Service Company.

The small private recreational area is owned and used seasonally by a hunting and fishing club The town of Brutus is indicated on the map because it seems likely to survive as the trading center of a small area

The land-use changes suggested in this paper are designed to improve agricultural conditions in Maple River Township by concentrating farms on the more productive areas. At the same time the cost of maintaining unnecessary public facilities in isolated areas will be reduced, though the size of state-owned tracts will be increased by the combination of separate tracts into consolidated units Such changes should result in better economic conditions.



# A HISTORY OF TAX-DELINQUENT LAND IN TOWNSHIP 24 NORTH, RANGE 1 EAST, OGEMAW COUNTY, MICHIGAN

GEORGE S MCINTIRE

**D**ESPITE a prolonged tax moratorium it now seems evident that the state-owned acreage of reverted lands in northern Michigan is due to increase. The first sale of delinquent lands since 1932 was held in May, 1938. Though the amount bid in by the state is not yet known, conservative estimates run as high as two million acres. Such lands consist mainly of second-growth cutovers and fire-denuded areas, with a scattering of abandoned farms where agriculture has been attempted on inferior soils.

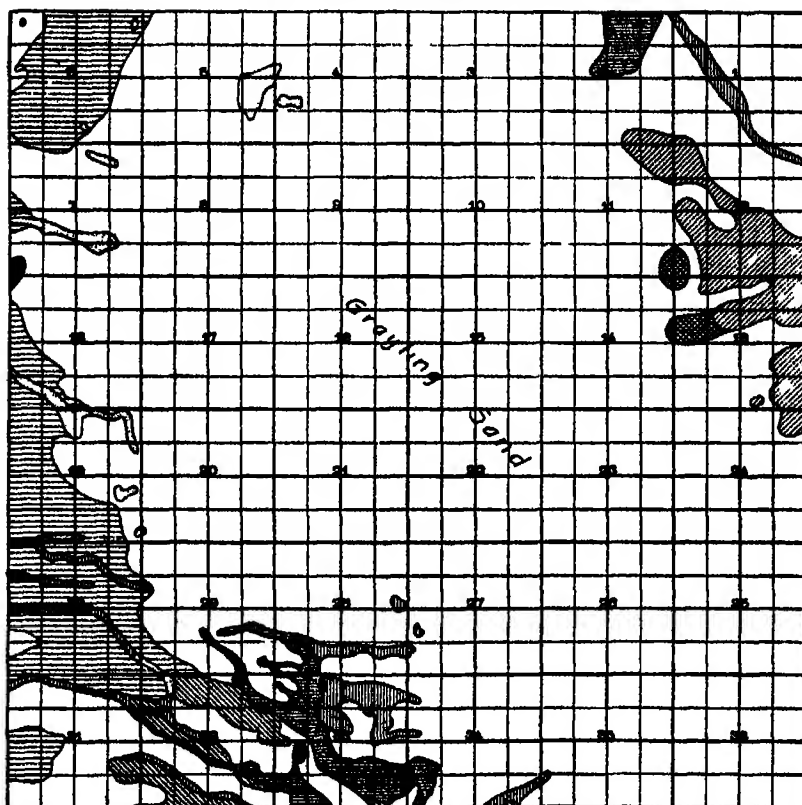
In order to obtain a clearer understanding of some of the factors which have resulted in northern Michigan tax delinquency a detailed investigation was made of the land-ownership history of a township containing a large proportion of land typical of that which has reverted to the state through nonpayment of taxes. Township 24 North, Range 1 East, in the northwest corner of Ogemaw County, was chosen for the study.<sup>1</sup> This area is within the boundaries of the Ogemaw State Forest, and part of it is within the Ogemaw Game Refuge also.

In physical character it is perhaps as typical of reverted land as any other tract of similar size that might be found. The areas occupied by the various soil types are shown in Figure 1.

The present forest cover consists of both planted and volunteer stands. Plantations of jack pine and Norway pine occupy many of the old cleared fields, whereas jack pine and oak predominate in the second-growth stands on the sandy uplands. Poplar has replaced the maple-elm-basswood forests on the loam soils, but the swamps have in general retained their virgin forest types.

<sup>1</sup> In order to simplify the compilation and checking of acreages the area of each description was figured as 40 acres, which makes a total area for the township of 23,040. This is 34.15 acres less than the actual area.

T. 24 N., R. 1 E., Ogemaw County



## KEY TO SYMBOLS










	GRAYLING SAND 19 426 ACRES		RIFLE SWAMP TYPE, 496 ACRES
	ROSELAWN SAND, 622 ACRES		GREENWOOD SWAMP TYPE 201 ACRES
	SAUGATUCK SAND 279 ACRES		ROSELAWN GRAVELLY SANDY LOAM 40 ACRES
	OGE MAW SANDY LOAM, 1656 ACRES		OGE MAW GRAVELLY SANDY LOAM, 15 ACRES
	NEWTON SANDY LOAM 303 ACRES		

FIG. 1. Soil types

According to the soil-type descriptions the original predominating forest growths most commonly occurring on these soils are indicated in the following table. The order of the species denotes their relative abundance in the stand, with the names of those occurring most frequently placed first.

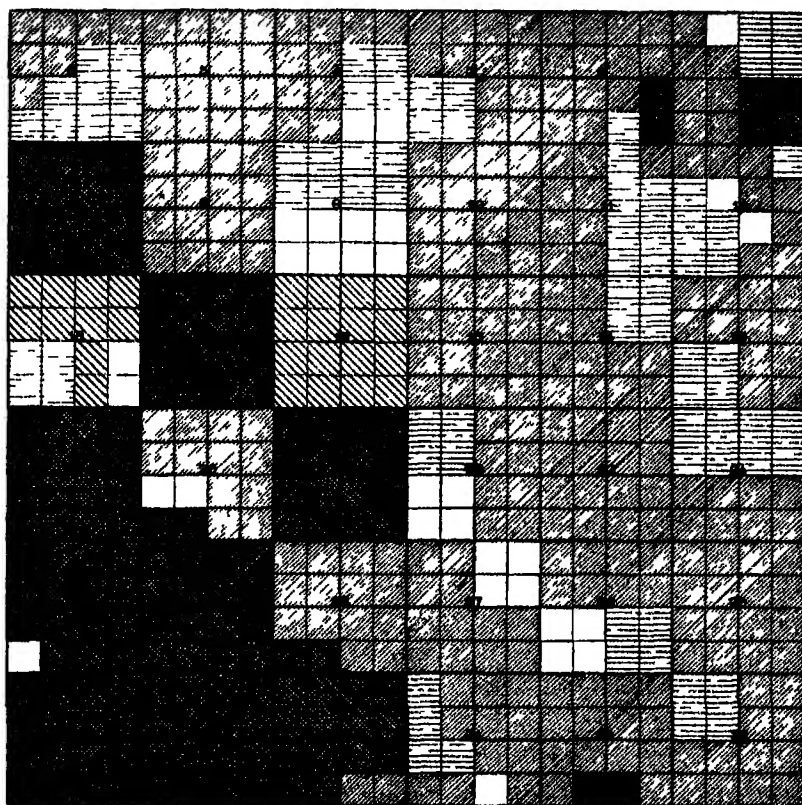
<i>Soils</i>	<i>Species</i>
Grayling sand	Norway pine and white pine
Roselawn sand	White pine and Norway pine
Roselawn gravelly sandy loam	White pine and Norway pine
Saugatuck sand	Large white pine
Ogemaw sandy loam	Mixed upland hardwoods, including hard maple, elm, basswood, beech, and yellow birch, with scattered white pine
Ogemaw gravelly sandy loam	Upland hardwoods of hard maple, elm, bass- wood, ash, and hemlock, with Norway pine also on the drier sites
Greenwood peat	Bog mosses and shrubby growth such as laurel, Labrador tea, blueberry, and cranberry
Rifle peat	Tamarack, spruce, balsam fir, and white cedar, with occasional patches of black ash, red ma- ple, and balm of Gilead

Title to all lands in Michigan was first vested in the central government at Washington, and the idea seems to have been to get these lands into private ownership as soon as possible. We find that in the area under consideration seven legislative acts were employed in disposing of them. Two of these gave title to the state. The School Land Grant Act of 1836 provided that Section 16 of every township be given to the state for primary-school purposes and the Swamp Land Grant Act of 1850 transferred the swamp lands to the state. A third act passed at an early date authorized grants for the construction of railroads. The remaining four acts provided for the direct transfer of lands to individuals, presumably with reward, exploitation, or settlement as their objective.






If, as has been stated, the purpose of the Federal Government was to dispose of these lands as soon as possible, we must admit that the means employed were most effective (Fig. 2). The first record of disposal shows a railroad grant of 4,320 acres, which was approved in 1861 and for which patent was issued to the Jackson, Lansing, and Saginaw Railroad in 1869. In all, 6,120 acres were disposed of from



T 24 N, R 1 E, Ogemaw County



## KEY TO SYMBOLS

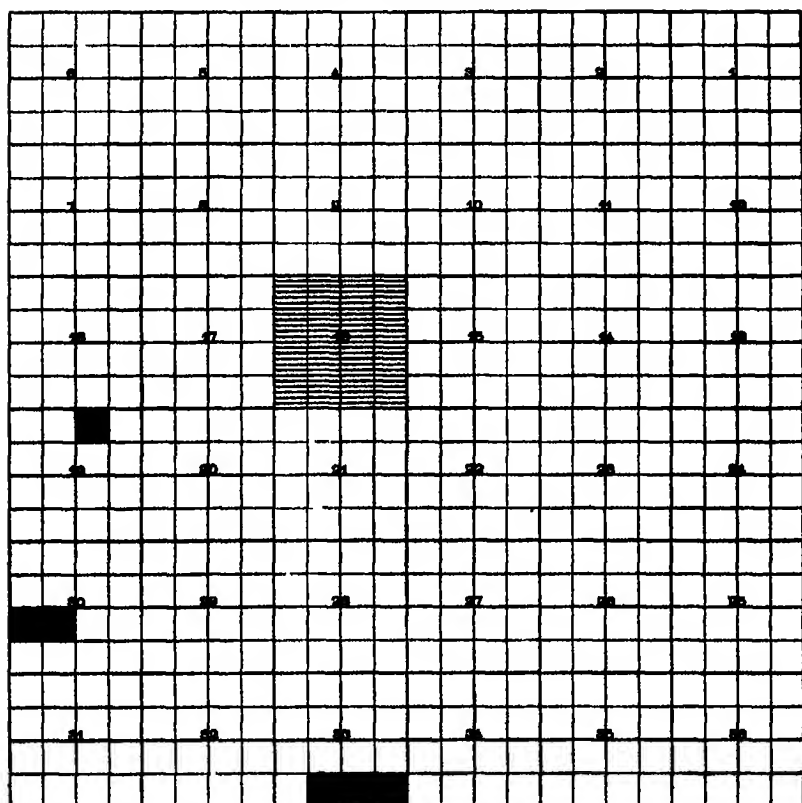
	1861 TO 1870 6120 ACRES		1891 TO 1930 1040 ACRES
	1871 TO 1880 11480 ACRES		TRANSFERRED TO STATE IN U.S. GOVERNMENT EXCHANGE 1931 1240 ACRES
	1881 TO 1890 3160 ACRES		

TOTAL AREA 23 040 ACRES

FIG 2 Disposal of land by state and federal agencies

1861 to 1870 inclusive, and this was increased to 17,600 acres by the end of 1880. During the next decade the Federal Government parted with title to 3,160 acres, but from 1891 to 1930 Federal ownership

## T 24 N, R 1 E, Ogemaw County



## KEY TO SYMBOLS



SCHOOL LANDS GRANT, ACT OF JUNE 23, 1836  
640 ACRES



SWAMP LANDS GRANT, ACT OF SEPT 28, 1850,  
240 ACRES

FIG 3 Federal grants to the state

was decreased by only 1,040 acres. The last of the Government holdings, comprising 1,240 acres, were transferred to the state in 1931.

Federal grants to the state in Township 24 North, Range 1 East, included only 240 acres which had been listed as swamp and 640 acres of primary-school land (Fig. 3). The 240 acres of swamp land

were disposed of by 1889, but the 640 acres of primary-school land remained in state ownership until 1906, when they were sold for fifty cents an acre

The method by which the total area of 23,040 acres was disposed of is shown in Figure 4

We have endeavored to demonstrate that the early objectives of both the Federal and the state agencies to put the land into private ownership were in the main accomplished prior to 1880. How is it, then, that today we find the state in possession of 19,180 acres as against a total private ownership of only 3,220 acres?

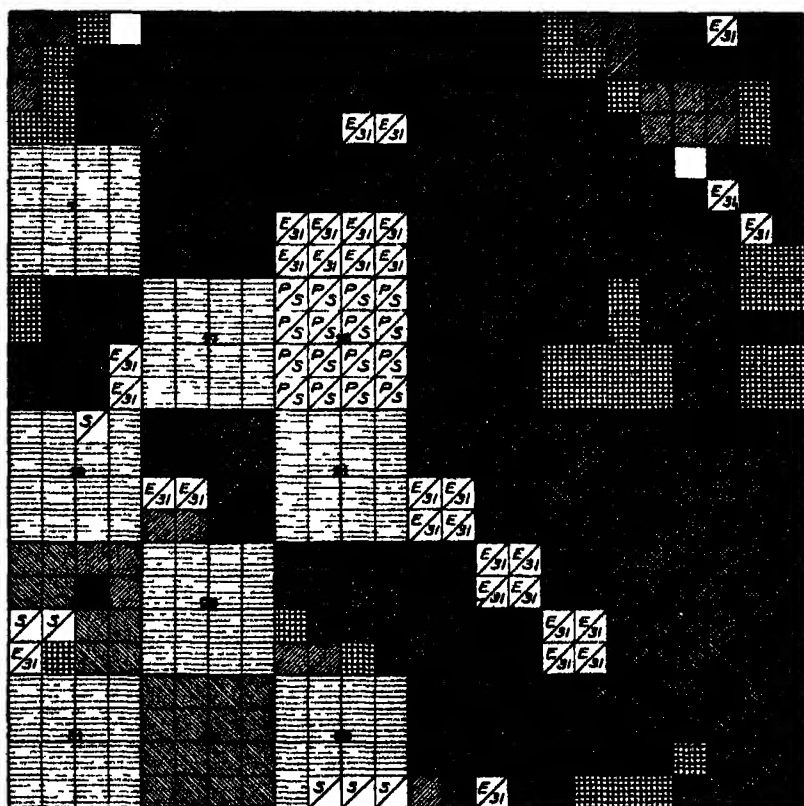
An analysis of the method of acquisition (Fig. 5) of these state lands reveals that 9,860 acres reverted to public ownership through nonpayment of taxes, that 7,620 were acquired by exchanging reverted tax lands in other localities either with private or public agencies, and that only 1,700 were obtained by purchase.

We have also found through field examination and by consulting such other sources of information as we could discover that of the present 19,180 acres of state land at least 12,560 acres, representing some ninety-one different owners, were once in farms (Fig. 6) The Land Economic Survey maps of 1923 show twenty-two houses in the area, six of which were then occupied. Only one house now remains, and though it is lived in from time to time the occupants do no farming.









Today it is generally assumed that the farming operations followed lumbering, occupying the cutover land after the timber had been removed. This is no doubt true in many if not most instances. But our findings tend to point otherwise in the area under discussion. An examination of the General Land Office plats indicates that by far the most of the lands in the township were taken up by individuals in quarter-section tracts and were located on the Grayling sand plains. These plains were more or less open at the time the first Government survey was made or else supported a ragged patchy growth of jack pine, with the larger Norway pine and white pine occurring only as occasional individuals.

It has often been assumed that the virgin forest was a direct reflection of site capacity. This may or may not be true. It is today a well-known fact that the pine plains are among the areas of highest fire hazard, and it is inconceivable that the growth on them, under what we think of as virgin forest conditions, may not just as well have been a direct reflection of this high fire hazard as of site ca-

T 24 N, R. 1 E, Ogemaw County



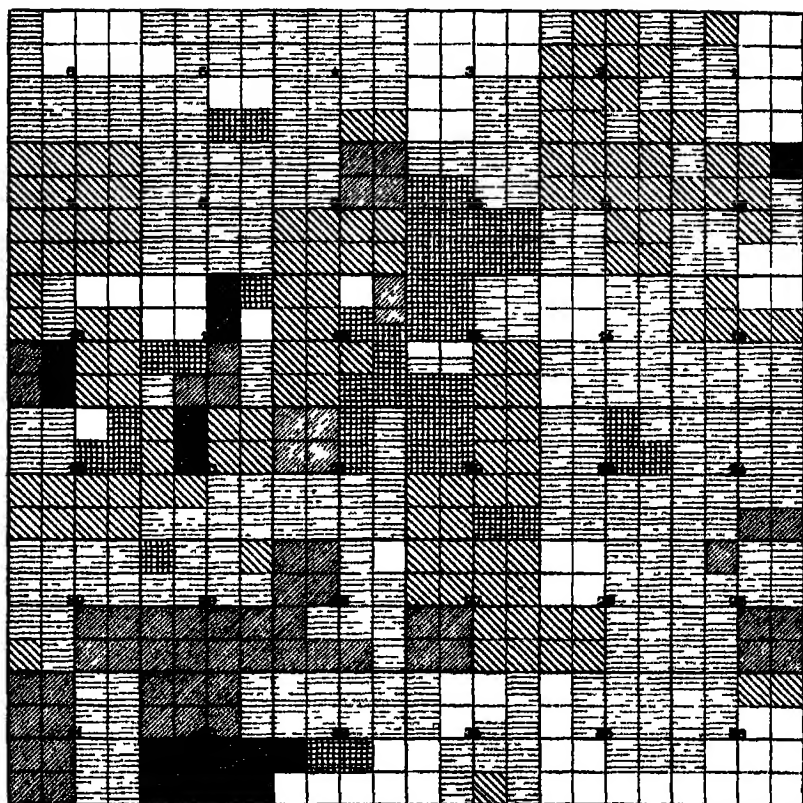
## KEY TO SYMBOLS

	HOMESTEAD ENTRY 13 200 ACRES		RAILROAD GRANT (J L & S) 4320 ACRES
	AGRICULTURAL SCRIPT 960 ACRES		SWAMP LAND 240 ACRES
	1812 WARRANT, 840 ACRES		PRIMARY-SCHOOL LAND 640 ACRES
	SALE, 1520 ACRES		1931 EXCHANGE WITH STATE 1240 ACRES







NO RECORD 80 ACRES  
TOTAL AREA, 23 040 ACRES

FIG. 4. Method of land disposal by the Federal Government

T 24 N, R 1 E, Ogemaw County



## KEY TO SYMBOLS

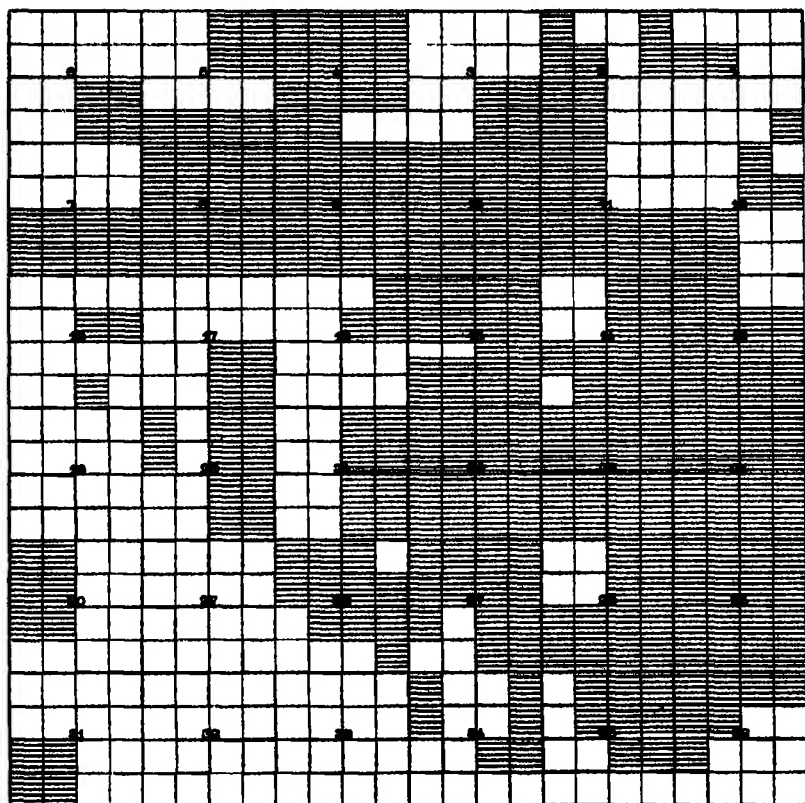
	TAX HOMESTEAD LAND 9860 ACRES		LAND ACQUIRED BY EXCHANGE WITH US GOVERNMENT 5200 ACRES
	LAND ACQUIRED BY PURCHASE 1700 ACRES		LAND BID IN BY STATE AT TAX SALE MAY, 1938 640 ACRES
	LAND ACQUIRED BY PRIVATE EXCHANGE 2420 ACRES		PRIVATELY OWNED LAND 3220 ACRES

TOTAL AREA, 23,040 ACRES

FIG 5 Present state ownership and method of acquisition

capacity Both Indians and trappers traversed these areas long before lumber operations began, and pine plains once burned over are especially susceptible to lightning fires

T 24 N, R 1 E, Ogemaw County



## KEY TO SYMBOL



PRESENT STATE LANDS ONCE OWNED AS FARMS, 12 560 ACRES  
(MADE UP OF 91 PARCELS)

TOTAL STATE OWNERSHIP IN TOWNSHIP, 19,180\* ACRES

FIG 6. Area of present state lands once owned as farms

With this thought in mind the original plats and survey notes were examined for evidences of burns in the area investigated. The exterior lines were run in 1837, but the interior subdividing was not done until 1846. The words "rolling poor sandy lands," "spruce pine [jack pine] plains," and "fire lands" are written across the larger portion of the plat occupied by the Grayling sand. A detailed ex-

T 24 N, R. 1 E, Ogemaw County

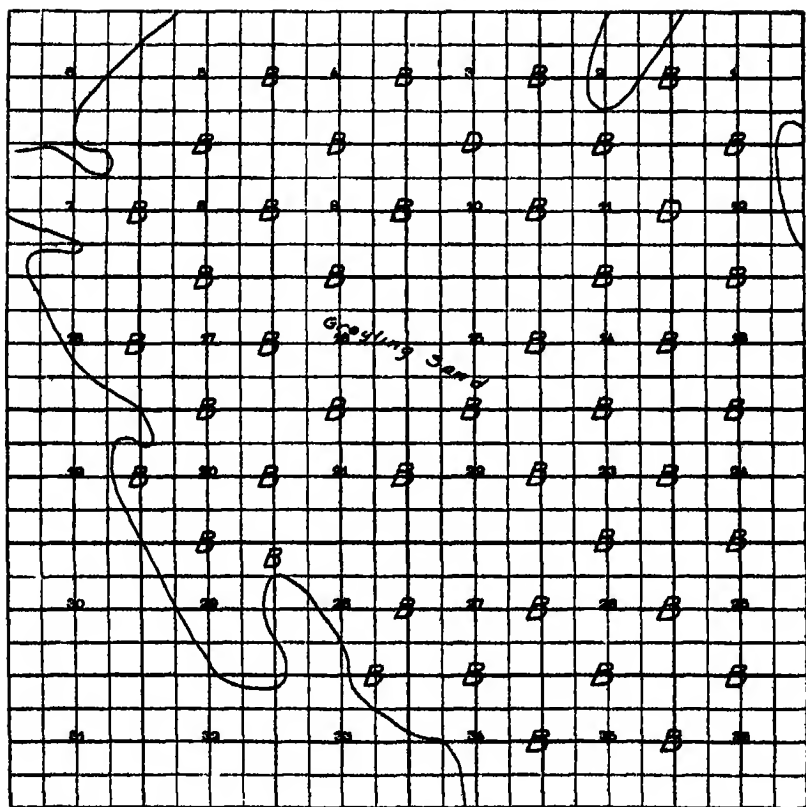


FIG 7. Chart showing the frequency with which burns were indicated on areas of the Grayling sand soil type at the time the General Land Office survey was made

- B*—Designates section lines on which burns were indicated one or more times in the notes of the General Land Office survey  
*D*—Designates section lines where dead timber was indicated in the notes of the General Land Office survey in such quantities as, presumably, to have been caused by previous fires

amination of the notes shows repeated references to burns, open lands, and dead timber. Figure 7 reveals a very definite correlation between these burned lands and the area of Grayling sand.

The original survey notes of several other townships similar in character were also examined with results no less striking. These

**T 24 N., R. 1 E., Ogemaw County**

[illegible]

**FIG. 8. Ownership resulting from disposal of land by the Federal Government**

findings are clear proof that forest-fire history is by no means restricted to the postlumbering era.

Our investigation of the old survey notes of these townships leads us to believe that the 16,520 acres obtained by homestead entry, agricultural script, 1812 Warrant,<sup>2</sup> or by direct purchase were in the main acquired for agricultural purposes. A more detailed analysis of ownership (Fig. 8) shows that one owner obtained 800 acres; another 280; and the remaining one hundred and three averaged only

<sup>1</sup> This refers to legislation which provided that the heirs or representatives of soldiers who had been killed in action or who had died in service should be entitled to 160 acres, to be surveyed at public expense.



143 It was, undoubtedly, common practice to secure lands by homestead entry with only the timber value in mind and with no thought of permanent settlement, but this does not seem to apply to this tract as these small holdings were concentrated on open areas or on those supporting only a patchy growth of comparatively inferior species. On the contrary, it appears that prospective settlers were looking for either open or easily clearable areas on which to settle. A prerequisite to such an attitude must have been almost complete ignorance of what constitutes good agricultural land. With this misapprehension, which was evidently dominant, it was doubtless quite easy for the settlers to convince themselves that the occupation of any kind of land in this new country would prove a profitable venture. The railroad was completed to Gaylord in 1873, and accessibility and development of the area were assured. The lumbering town of Beaver Lake was established in 1871, Ogemaw Springs in 1872, and Damon in 1880. All these settlements were only a few miles distant, and with the neighboring woods operations provided unlimited employment. It was a setup made to order for the land-sale campaigns of the railroads and other colonization agencies.

The railroad company lost no time in taking advantage of the situation. It had two kinds of lands for sale, those supporting valuable timber and those which did not. The former were sold with little effort, but many of the latter, including the "plains" areas, had to be disposed of for agricultural purposes or not at all, and it was on these areas that sales efforts were concentrated. The following extract from a booklet published by this company in 1875 is enlightening:

Lands timbered with maple, beech, basswood and ash are everywhere regarded as fertile and well adapted to agriculture. A large part of these lands are of this character. In other parts the soil is more sandy. Plains quite free from timber, and nearly ready for the plow, are also to be found. These lands, though offered at low prices [\$10 to \$25 an acre], possess the same qualities of soil as some of the best lands of England and the United States, and wherever lands of this kind have been subjected to an intelligent husbandry adapted to their character, they have produced well, and with less labor than the heavier soils. It may be said in general that the lands are adapted to all the crops grown in this latitude.

Specimens from these lighter soils have been subjected to numerous examinations, by eminent agricultural chemists, for the purpose of determining their productive ingredients, and in every case an abundance of lime, feldspar, and mica as well as silica or common sand have been found to exist. As these last-named minerals contain a large percentage of potash, the only thing which this

variety of soil seems to lack is vegetable matter. A good supply of this latter will make it exceedingly fertile, and can be easily supplied by clovering or turning under blue grass sod.

In another place the booklet states of Roscommon County: "Pine is the predominate timber but the land is in general well adapted for farming purposes. In the northern part of the county are found plains quite free from timber, and nearly ready for the plow."

It is further asserted that the precipitation also meets agricultural requirements, with the heaviest falls occurring in June and July. This statement, however, does not check with the records of the last twenty-five years.

It can readily be seen from these data that effort was made to stimulate settlement on light sandy soils. It is also reasonable to assume on the basis of Table I, which gives by years the acreages settled, that these efforts were effective. The completion of the railroad in 1873 does explain increased influx into the region, but it does not account for the apparent willingness to settle on these light sandy lands, if not actual preference for such areas.

Farms were established, and old-timers claim that an excellent crop of wheat was taken off the first year. They also admit that they did not get their seed back the second year. Work was plentiful, however, in the adjacent lumbering operations, and they had a place to live. The full effect of settling on unproductive lands was probably not felt until the surrounding timber was cut. When the lumber industry had passed on to other localities the settlers were forced to get their living from the soil. The inevitable period of abandonment followed.

Information obtained from the old inhabitants in the vicinity indicates that the peak of the farm population in this township was reached during 1885 and 1886, with abandonment starting in 1888. One farmer who lived on the area stated that approximately one half of the farms had been abandoned by 1891.

In 1893 a law was passed vesting in the state the title to tax-delinquent land, with the idea of making vast cutover areas available for homesteading and settlement. As a result of this act the state had, within a few years, come into possession of a large part of Township 24 North, Range 1 East. Among the first lands to revert were those light sandy soils which had been settled for agricultural purposes.

TABLE I  
ACREAGES OF LAND DISPOSED OF BY THE FEDERAL GOVERNMENT IN VARIOUS WAYS

Method of disposal	By years																				Totals		
	'66	'68	'70	'71	'72	'78	'79	'80	'81	'82	'83	'84	'85	'86	'87	'90	'92	'03	'06	'12		'13	
Homestead certificate				400	120	5,920	2,640	640	800	1,120	680	160		160	160			160		80	160		
Agricultural script	960																						
1812 War-rant *		200	360	160	120																		
Direct purchase	40		80	80	160	480	120	40				160	80			120	80		80				
Totals by years	1,000	200	440	640	400	6,400	2,760	680	800	1,120	680	320	80	160	160	120	80	160	80	80	160		
Totals by decades	1,640			10,880								3,440				80				240		16,520	

\* See footnote on page 427

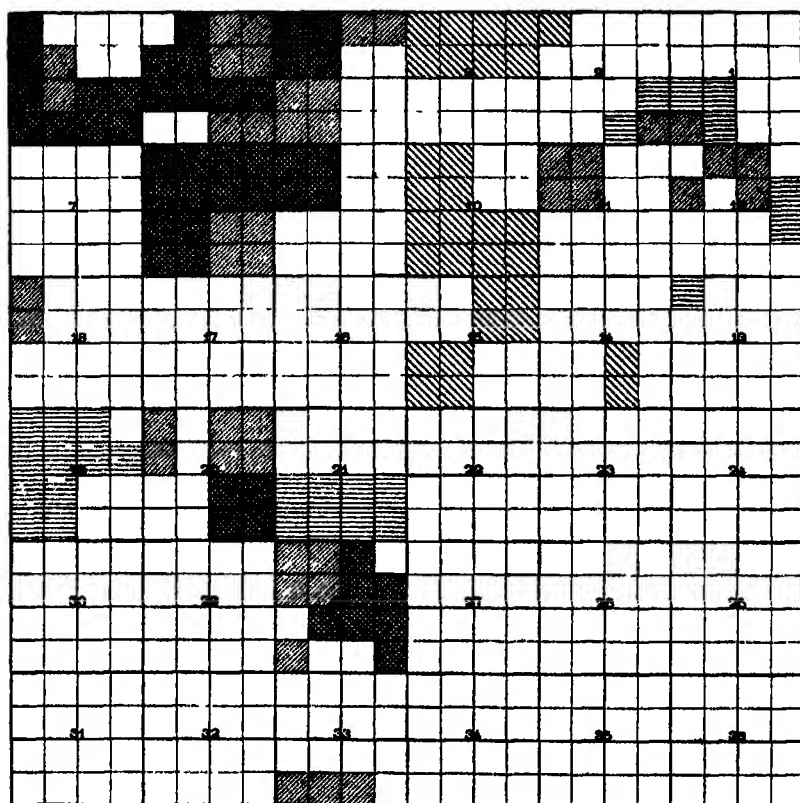
By 1900 it was realized by certain groups that many of the lands reverting to the state were not suited to agriculture. Nevertheless the old "plow-follow-ax" and "get-the-land-back-on-the-tax-roll" theories still dominated the state land policy, and 10,700 acres in the township studied, located largely on the sites of previous agricultural failures, were sold between 1903 and 1911 at an average price of seventy-three cents an acre.

These 10,700 acres represented twenty-four purchasers. Some of them, and particularly the former farmed areas, were obtained in forty, eighty, and one-hundred-and-twenty acre parcels, with agriculture again the objective. Human nature seems to be so constituted that we refuse to profit by the mistakes of others, particularly when results do not coincide with our own preconceived ideas. Even now persons making inquiry to the state for agricultural lands are mainly concerned with descriptions which are already the site of from one to four or five agricultural failures. Of course, the applicant always has a new kind of formula and is positive that it will work out successfully. However, most of the land disposed of during this period was obviously obtained for speculation, as cheap land for resale to a second crop of "suckers," but occasionally for timber remnants that for some reason had escaped previous operations.

Figure 9 shows the holdings of the four largest speculators, whose purchases, totaling nearly 6,000 acres, were scattered over most of the township. These men obtained other lands scattered similarly over many other townships in this general locality, and there is no question as to the speculative intent. The results of one of these ventures are shown on Figure 10. Most significant is the fact that, of the 1,760 acres purchased, 1,600 are again in possession of the state, and of this latter amount all except the eighty obtained by outright purchase came either directly or indirectly by the reversion route.

It has been demonstrated that abandonment and reversion have played an important part in the history of this township since it was first released from public ownership. It has been found that 17,480 of the 19,180 acres at present in the state-owned area are of reversion origin. But this is only part of the story. Study of the state land-office records (Fig. 11) shows that 8,600 acres reverted to the state once, 7,680 twice, and 120 three times. In addition, 640 acres were bid in by the state at the tax sale of May, 1938. But even this does

## T 24 N, R 1 E, Ogemaw County



## KEY TO SYMBOLS





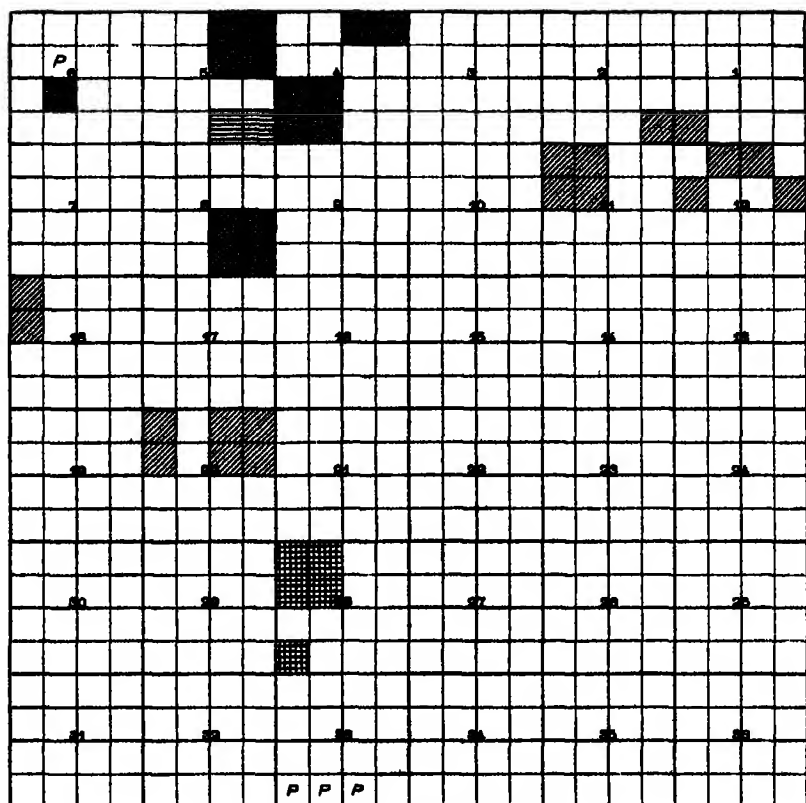
-  PURCHASED BY MR A, 1760 ACRES
-  PURCHASED BY MR B 1240 ACRES
-  PURCHASED BY MR C 1080 ACRES
-  PURCHASED BY MR D 1880 ACRES

FIG 9 Distribution of land sold to the four largest purchasers From 1903 to 1911 the state sold 10,700 acres of tax-homestead land at an average of \$0 73 per acre

not give the whole picture The mechanics of the administration of the tax-delinquency law up to 1937 often necessitated a lag of a

T 24 N, R 1 E, Ogemaw County



## KEY TO SYMBOLS






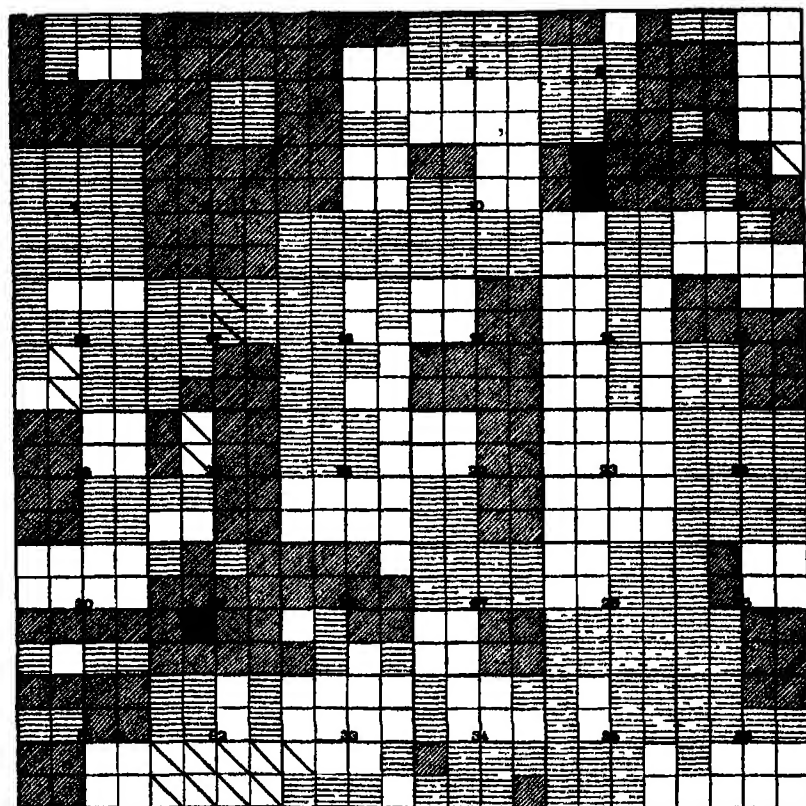
- |   |  |
|---|--|
|  REVERTED TO STATE IN 1926,<br>600 ACRES   |  ACQUIRED BY STATE IN PRIVATE<br>EXCHANGE, 1929 200 ACRES |
|  ACQUIRED BY STATE IN U.S.<br>GOVERNMENT EXCHANGE<br>1930, 80 ACRES<br>1935, 640 ACRES |  ACQUIRED BY STATE BY<br>PURCHASE, 1934, 80 ACRES         |
|   |  PRIVATE OWNERSHIP, 160 ACRES                             |

FIG 10 Present status of 1,760 acres of tax-homestead land purchased from the state in 1911 by one person, at \$1.00 per acre

decade or more between abandonment and state possession. Had the present provisions of the law been in effect all these years the

T 24 N, R 1 E, Ogemaw County



## KEY TO SYMBOLS

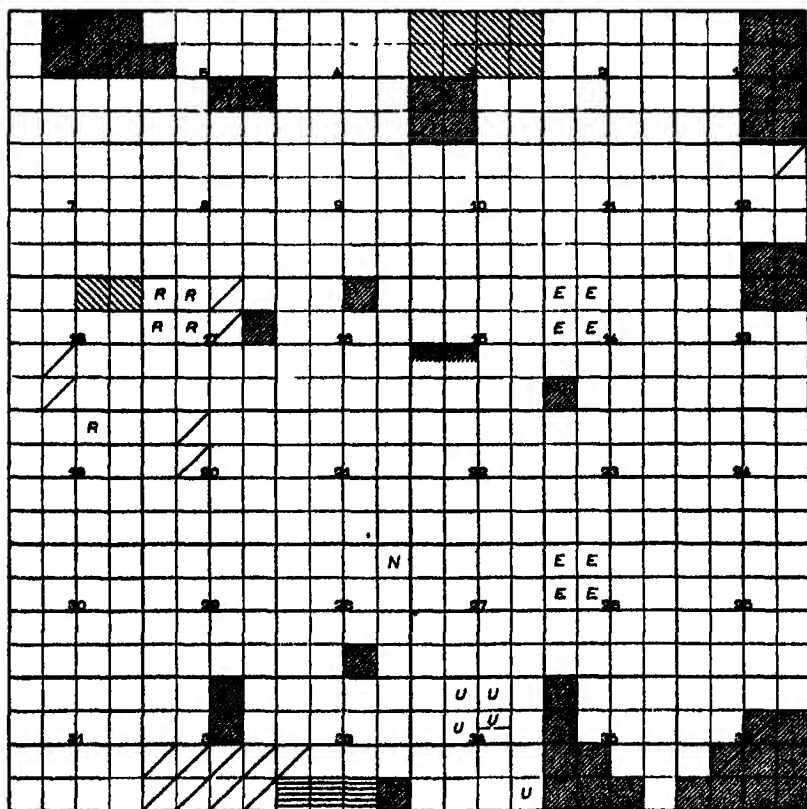
	REVERTED ONCE, 8600 ACRES		REVERTED THREE TIMES, 120 ACRES
	REVERTED TWICE 7680 ACRES		BID IN BY STATE AT TAX SALE, MAY, 1938 840 ACRES

Fig 11 History of land reverted to the state through tax delinquency

rate of the cycle of reversion might have been considerably accelerated

It has been generally recognized that a certain amount of land adapted to private ownership is desirable in the more extensive state-administered projects, the one exception to this being game

T. 24 N, R. 1 E, Ogemaw County



## KEY TO SYMBOLS

 SPECULATION - LAND  
OR TIMBER 1960 ACRES

 RECREATION, 400 ACRES

 HELD FOR DEVELOPMENT AS  
FROG FARM, 120 ACRES

 BID IN BY STATE AT MAY, 1938  
TAX SALE 640 ACRES

 TITLE UNSATISFACTORY-  
REFUSED BY STATE 200 ACRES

 NOT FOR SALE - REASONS  
UNKNOWN 180 ACRES

 ESTATE PROPERTY - HEIRS  
CANNOT AGREE, 320 ACRES

 NOT ON TAX ROLL, 40 ACRES

TOTAL PRIVATE LAND 3220 ACRES

(DOES NOT INCLUDE 640 ACRES BID IN BY  
THE STATE AT MAY TAX SALE)

FIG. 12. Intent in ownership of lands remaining in private possession



refuges. However, a knowledge of the lands remaining in private ownership in the area in question and an inventory of the intent for which these lands are held (Fig. 12) would indicate that state ownership is destined to increase even beyond its present status.

The story of Township 24 North, Range 1 East, is more or less typical of all the present state-owned lands of tax-delinquent origin as well as of those in the process of reverting to state ownership by this medium. With few exceptions these areas are not suited to private ownership. The very procedure by which the state acquires title is in itself a pretty efficient screening process. Nevertheless the lands are carefully classified by the Conservation Department to determine whether they are suited to private or public management. If analysis shows adaptation for private ownership it is the policy of the state to dispose of them as occasion offers.

But regardless of this policy and in spite of past history the old theories of "colonization" and "get the land back on the tax roll at any cost" still have many advocates, some sincere and some selfish. These interests are again active and will be increasingly so as the results of the tax sale of May, 1938, become more generally known.

DEPARTMENT OF CONSERVATION  
LANSING, MICHIGAN

# LAND-OWNERSHIP PATTERNS IN RELATION TO LAND TYPES IN DICKINSON COUNTY, MICHIGAN \*

IVAN F SCHNEIDER

**L**AND ownership has changed in northern Michigan during the last half century. In this section of the state the greatest expansion in the field of agriculture took place between the years 1900 and 1920. Large tracts of hardwood timber were still standing, however, in the western part of the Upper Peninsula at the close of the agricultural boom period in 1920. Consequently, in contrast with the situation in the Lower Peninsula, where a large percentage of the land had been cleared for agricultural use immediately after the logging operations, only a small section of the Upper Peninsula cutover areas had been prepared for similar use by the same date. Ownership changed with the removal of timber and minerals, with the utilization of land for recreational purposes, and with agricultural expansion.

Information concerning the types of ownership which were subjected to change, the rate of the changes, and the effect which the quality of the soil may have had on them is of importance to federal, state, and county agencies concerned with land planning and proper land utilization. Such information is useful to the Department of Conservation, also, which is charged with the administration of properties reverting to state ownership through tax delinquency.

Some material has been gathered in recent years concerning this subject. Renne<sup>1</sup> has shown the importance of analyzing the ownership pattern in determining future land use in Montana. McMurry and Greenshields<sup>2</sup> have pointed out that in Roscommon County,

\* Authorized as Journal Article No. 403, N. S., from the Michigan Agricultural Experiment Station.

<sup>1</sup> Renne, Roland R., "Montana Land Ownership," Agricultural Experiment Station, Montana State College, Bull. 322, 1-58, 1936.

<sup>2</sup> McMurry, Kenneth C., and Greenshields, Mary, "Some Geographic Relationships of Tax Delinquency in Michigan," *Pap. Mich. Acad. Sci., Arts, and Letters*, 14 (1930) 377-387, 1931.

Michigan, practically all state lands are either sandy or swampy. To further this investigation the land-ownership patterns for Dickinson County, Michigan, were compared by the author in an effort to determine the trends in ownership, the rate at which changes in types were taking place, and to ascertain whether any correlation exists between the changes in ownership and the physical characteristics of the soil.

Dickinson County is in the west-central part of the Upper Peninsula of Michigan, it comprises a part of the Superior Highland. The Menominee Iron Range crosses the southern half of the county. Iron Mountain, the principal city and the county seat, is approximately three hundred miles north of Chicago. The area of the county is 776 square miles, or a total of 496,640 acres.

The land ownership of the county may be conveniently divided into four types, namely, by public agencies; by cities and villages, by agricultural holdings, and by nonagricultural holdings. The public-agency ownership has been subdivided into federal, state, and county holdings. The nonagricultural lands have been arranged in three classes, with the size of the holding used as a basis: 640 acres or less, 640 to 5,000 acres, 5,000 acres or more.

The total acreage of each type of ownership in 1916 and 1937 and the percentage of the total area of the county which it occupied are computed and tabulated in Tables I and II.

In comparing the quantitative changes in land ownership (Table II) one finds noteworthy differences. The acreage devoted to agriculture has increased by 171 per cent, that in public holdings changed still more rapidly — by 731 per cent. For the most part the increase in public holdings resulted from a relinquishing of nonagricultural areas by timber, mining, and speculative companies.

Two maps which show the distribution of the types of land ownership for the years 1916 and 1937 have been drafted. An identical color scheme was used in both in order that the distribution of each type might be brought out more effectively. The maps are too detailed for reproduction here.

During the summer of 1938 the Section of Soils of the Michigan Agricultural Experiment Station and the Michigan State College Conservation Institute cooperated in making a natural land-type survey in Dickinson County. These types were subsequently consolidated under four headings and rated for agricultural purposes on the basis of their physical characteristics, namely: first class (dom-

TABLE I

ACREAGE AND PERCENTAGE OF DICKINSON COUNTY IN EACH TYPE OF LAND OWNERSHIP IN 1916 AND 1937

Type of ownership	Acreage		Percentage of total acreage	
	1916	1937	1916	1937
Public agencies				
Federal Government	1,880	0	38	0
State of Michigan	12,840	104,760	2 60	21 09
Dickinson County	0	2,920	0	58
Cities and villages	5,200	11,000	1.01	2 22
Agricultural	37,760	64,840	7 61	13 05
Nonagricultural				
640 acres or less	59,240	42,760	11 94	8 61
640 to 5,000 acres	106,680	83,680	21 48	16 86
5,000 acres or more	278,040	186,680	54 98	37 59

TABLE II

ACREAGE IN DICKINSON COUNTY CLASSIFIED BY TYPES OF LAND OWNERSHIP AND PERCENTAGE OF CHANGE BETWEEN 1916 AND 1937

Type of ownership	Acreage		Percentage of change since 1916
	1916	1937	
Public agencies	14,720	107,680	731 5
Cities and villages	5,200	11,000	211 5
Agricultural	37,760	64,840	171 7
Nonagricultural	428,960	313,120	72 9

inantly well-drained loams and clay loams); second class (dominantly sandy loams intermixed with loams and light sandy loams), third class (sandy loams and light sandy loams), and fourth class (sands, rock areas, and swamps) A physical land-classification map, too detailed to be reproduced here, was drafted to show the distribution of the four classes of soil. Changes in the type of ownership were analyzed in relation to the various types of land represented on the map.

In 1916 the Federal Government owned 1,880 acres of land in Dickinson County, most of which were in forty- and eighty-acre tracts scattered over the northern part of the county. Between 1932 and 1937 this land was exchanged for state holdings in other

counties This action made possible the "blocking in" of national forests in these counties, but, as a consequence, the Federal Government no longer held title to land in Dickinson County in 1937

The largest change in any type of ownership took place in the state holdings, with an increase from 12,840 acres in 1916, or 2.6 per cent of the area of the county, to 104,760 acres in 1937, or 21.09 per cent of the county Such lands were acquired by reversion of title to the state for nonpayment of property taxes and by state purchase for public hunting grounds The acquisition through purchase was made in areas in which there was already a large blocking of state lands

The amount of the state land varies among the townships from small scattered holdings in the vicinity of Iron Mountain and Norway to more than 80 per cent in the northeastern townships in the Escanaba River game tract When the distribution of the state land was compared with the physical land-classification map, a marked correlation was noted between state-owned areas and fourth-class land of the rock-knob type Further comparison in the northern part of the county showed, however, a widespread distribution of state holdings in all classes of land They are found on first-class land in T 41 N, R 27 W, T 42 N, R 27 W, and T 43 N, R 28 W; on second-class land in T 44 N, R 28 W, and T 43 N, R 28 W; and on fourth-class land in T 44 N, R 27 W, and T 44 N, R 29 W The acreage held by the state on the better-class land was even more extensive before approximately 3,000 acres were taken over in 1932 and 1933 as homesteads in the Hardwood Resettlement Project The gain in state holdings was not made at the expense of agricultural land except in the case of a few isolated "homesteaders" who allowed their lands to revert owing to such causes as lack of roads, schools, and community services rather than the pooriness of the soil

County ownership rose from no holdings in 1916 to 2,920 acres in 1937 The present holdings are devoted to such public recreational use as county parks and game preserves, and also serve to provide access to streams No relationship exists between this type of ownership and the quality of the soil

The area occupied by cities and villages doubled between 1916 and 1937. This growth was caused by the establishment of the Ford Motor Company plant at Kingsford and by the extension of the corporate limits of Norway and Iron Mountain

The agricultural holdings mounted from 37,760 acres in 1916 to 64,840 acres in 1937. This increase is accounted for by several factors. The largest gain resulted from the removal of forests and the subsequent clearing of land in areas where farming was already being carried on. The second factor was the construction of additional and better roads, which made possible the development for agricultural purposes of tracts which had hitherto been inaccessible. The relocation of State Highway 95 from Iron Mountain to Randville opened up a large block of country for pioneer settlement. A third factor was the establishment of the Hardwood Resettlement Project, mentioned previously, by which unemployed factory workers obtained lands under the provisions of the State Homestead Act. These "homesteaders" secured further help from the Federal Government, which granted loans for equipment and stock, and from the Ford Motor Company, which aided in the construction of buildings and the drilling of wells. This assistance gave the pioneer project some degree of stability.

For the most part, the large tracts of nonagricultural land were owned by companies or corporations which had acquired them in anticipation of their having timber or mineral resources. It was noted that these holdings of 5,000 acres or more had decreased from 273,040 acres in 1916, or 54.98 per cent of the area of the county, to 186,680 acres in 1937, or 37.59 per cent. The greater part of this loss was gained by the state holdings. The distribution of this acreage in relation to the quality of the soil has already been discussed (see p. 440). The second division of the nonagricultural land, consisting of holdings of between 640 and 5,000 acres decreased from 106,680 acres in 1916, or 21.48 per cent of the county, to 83,680 acres in 1937, or 16.86 per cent. The holdings of less than 640 acres declined from 59,240 acres in 1916, or 11.94 per cent of the total area, to 42,760 acres in 1937, or 8.61 per cent. The rate of decrease in the smaller holdings has been retarded to some extent by an increase in acreage of land used for recreation. At the present time more than 11,000 acres, or about 2 per cent of the county, are owned by individuals or clubs for this purpose. These areas are scattered throughout the county, and their distribution bears no relationship to the classification of soil.

Ownership of this nonagricultural group was largely acquired for the potential timber and mineral resources, and the quality of the soil

received little consideration. Consequently, when the lumber had been marketed, the land was of no further use to the owners; taxes were not paid, and eventually the land reverted to state ownership. This reversion took place regardless of the physical characteristics and the inherent productivity of the soil. Companies which held land solely for its mining possibilities continued or discontinued payment of property taxes in accordance with favorable or adverse reports of geologic surveys and diamond-drill explorations. Large acreages which passed to state ownership during the period under study are located in the Pine Creek rock-knob area, a fact which may be taken to indicate that mineral resources are limited in the south-central part of the county.

If the present trend from private to public ownership in nonagricultural lands continues, it is probable that within the next twenty years more than 75 per cent of Dickinson County will have passed into state ownership and administration.

#### CONCLUSIONS

1 A marked change has taken place in the types of land ownership in Dickinson County between the years 1916 and 1937.

2 The acreages held by public agencies, cities and villages, and agricultural ownership groups have increased at the expense of non-agricultural holdings.

3 The greatest increase in acreage occurred in state holdings.

4 The greatest decrease in the nonagricultural acreages took place in tracts of 5,000 acres or more owned by timber, mining, and speculative companies.

5 Much of the acreage which reverted to state ownership is classified as poor soil, but it is significant that timber and mining companies ceased to pay taxes in the better soil areas when their original intent in ownership had been fulfilled.

6 Nonagricultural lands of the county are rapidly passing from private to public ownership. Some of this acreage will be converted to agricultural use in the future, but, if the present trend continues, it is reasonable to assume that within the next twenty years more than 75 per cent of Dickinson County will have passed into state ownership and administration.

## THE 1938 TAX SALE IN MICHIGAN

MARY C STIRLING AND KENNETH C. McMURRY

**I**N MAY of 1938 the State of Michigan resumed the tax sale, which through the action of the legislature had been discontinued after the sale of 1932. Thus the delinquencies of six years had accumulated for the sale of 1938.

The maps entitled "Tax Sale, 1938" (Figs 1-2) show to scale the acreage bid to the state. It is estimated, in terms of past experience, that within a year seventy-five per cent of this land will have become state-owned and hence a part of the public domain in Michigan. The expected increase is about two million acres, which will almost double the present state-owned area. The interpretation of these maps and the understanding of certain peculiarities of the patterns and their implications depend upon a knowledge of the background of development of the state public domain.

The year 1893 marked the recognition of the public domain as a problem in Michigan. The tax act then passed laid down the basis upon which we have operated, with only minor exceptions, up to the present time. That act provided for the assumption of ownership by the state of all lands five years tax-delinquent, their designation as tax-homestead lands, and the opening up of these areas to settlers on a basis similar to that of the Federal Homestead Acts.

Tax delinquency had existed long before the tax act of 1893. During the preceding twenty-five or thirty years the pinelands had been widely abandoned and had reverted to the state after they were cut. Attempts had been made in many and devious ways to put them back into private ownership, but no satisfactory solution of the problem was found. Thus the act of 1893 was the first concerted effort to meet the situation.

In 1896 the first tax sale held under the new act occurred near the beginning of a time of greatly increased delinquency (Fig 3). For about ten years thereafter, a period corresponding with the end of pine lumbering on a large scale in Michigan, vast areas of pineland



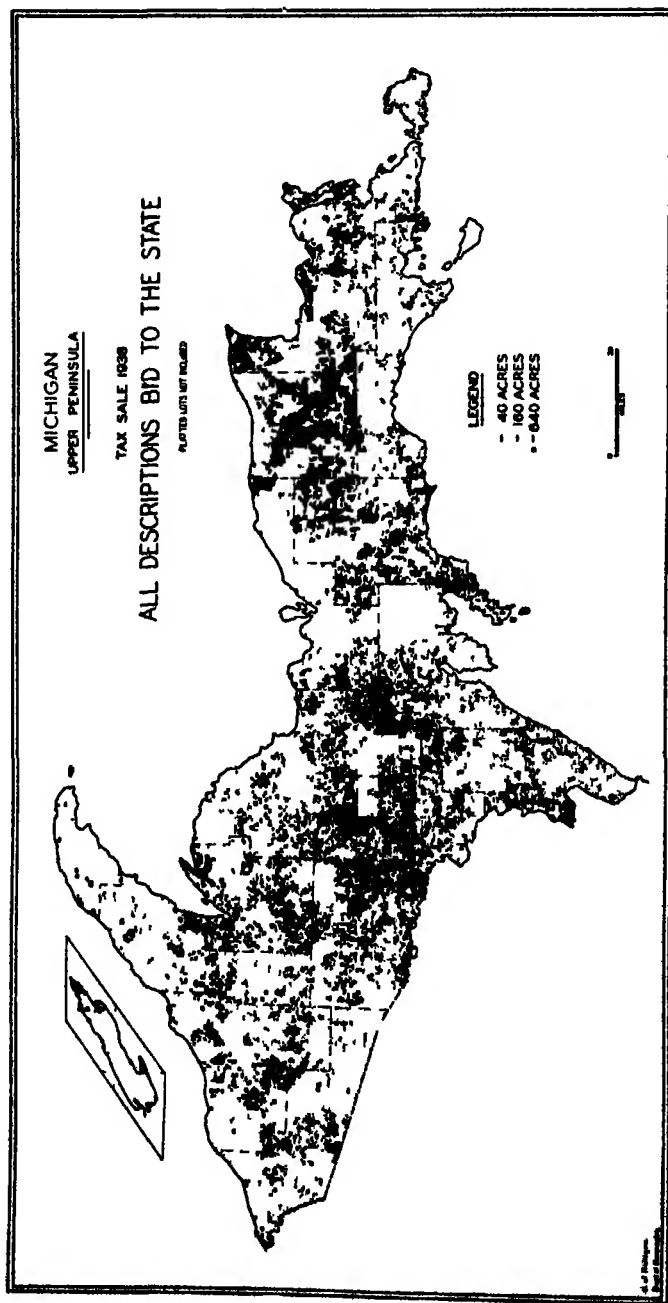


FIG 1

(The data were compiled from county tax records in the office of the auditor general, at Lansing, Michigan.)

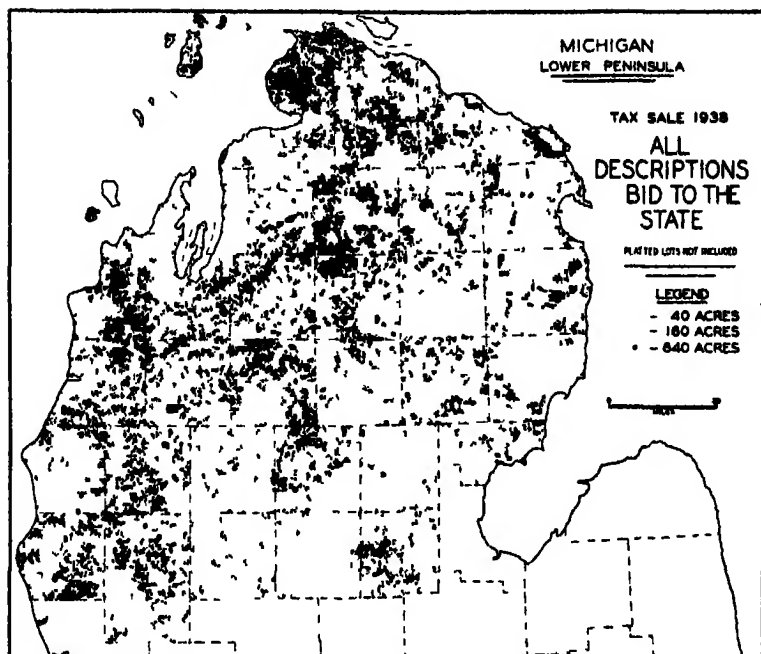


FIG 2

(The data were compiled from county tax records in the office of the auditor general, at Lansing, Michigan )

reverted to the state and greatly accentuated the problem. Within a few years the homestead plan of absorption of the public domain proved to be an almost complete failure. Though numerous homesteads succeeded, many failed because of the poor soil of most of the land. A large proportion of the homesteads were fraudulent in that their owners had never intended permanent settlement, but had used the law to provide themselves with lands for timber scavenging and with locations for trespass on adjacent state and private forests. Such homesteads were quickly abandoned, often before the required five-year period of residence had elapsed, and in several years such reversion exceeded in acreage that of the new homesteads taken up. No great proportion of the tax lands was ever used, and the total acreage in state hands increased steadily and rapidly.

To meet this situation a new law was passed in 1901 which placed

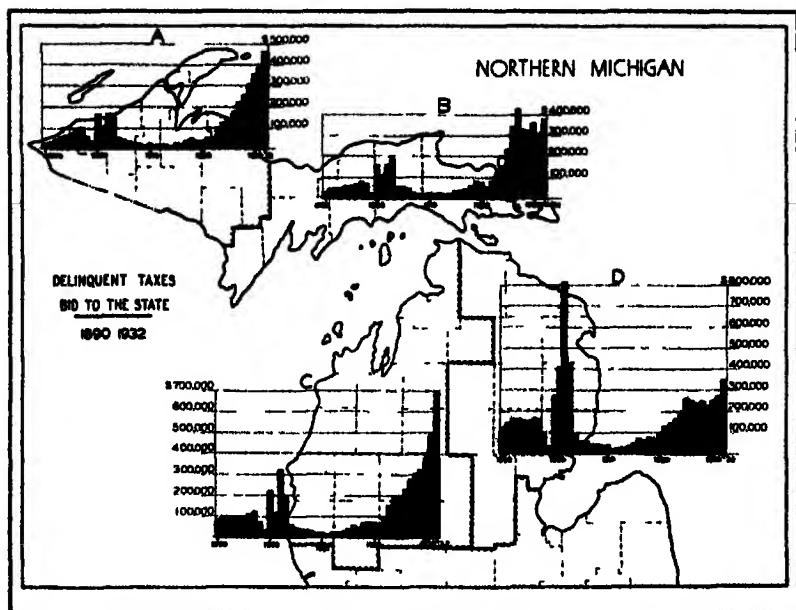


FIG 3

Groups of counties included in the graphs are as follows A, Baraga, Dickinson, Gogebic, Houghton, Iron, Keweenaw, Marquette, Ontonagon; B, Alger, Chippewa, Delta, Luce, Mackinaw, Menominee, Schoolcraft, C, Antrim, Benzie, Charlevoix, Clare, Emmet, Grand Traverse, Isabella, Kalkaska, Lake, Leelanau, Manistee, Mason, Mecosta, Missaukee, Newaygo, Oceana, Osceola, Otsego, Wexford, D, Alcona, Alpena, Arenac, Cheboygan, Crawford, Gladwin, Iosco, Midland, Montmorency, Ogemaw, Oscoda, Presque Isle, Roscommon

(The data were compiled from annual reports of the auditor general, Michigan, 1890-1932 )

the lands on sale in any quantity to any buyer From 1902 to 1909 more than a million acres were sold in this way,<sup>1</sup> with an average return to the state of about eighty cents an acre Great tracts were bought at these nominal prices and stripped of their residual timber resources, which in many cases were considerable At this time, too, were purchased most of those large blocks of land operated by the real-estate speculators and colonization outfits to the great detriment

<sup>1</sup> Data compiled from the Annual Reports of the Commissioner of the State Land Office, Michigan, 1902-09.

of Michigan's agricultural reputation and with social and economic loss to most of the settlers connected with them

The outcome of this process was so unsatisfactory that legislative action to alter the conditions quickly became necessary. A commission was appointed in 1907 to investigate the land and forest problem. The recommendation for the creation of a public domain commission came out of its study and report, which showed very clearly the unfortunate abuse of the land.

The act creating the Public Domain Commission in 1909 provided for a permanent agency to administer the public domain, for the establishment of state forests, and for the beginnings of a fire-control program. This was the first definite recognition of the state's responsibility for permanent administration of the public domain. In 1921, as a part of a general reorganization of state government, a further consolidation of land agencies was effected by instituting the Department of Conservation.

Before 1920 the bulk of the public domain was residual from the great period of pineland abandonment. From 1905 until about 1920 the problem of tax delinquency declined to such an extent that it seemed unimportant. This was a period of some agricultural expansion, to be sure, but chiefly one of hope for an agricultural future. During this period of land booming and speculation the accretion to the public domain was slow. It was the thought of many people that the tax-delinquency problem would no longer be significant.

By 1920 tax delinquency began to show again in a major way, and throughout the north became increasingly severe. The fact should be emphasized that this problem recurred many years in advance of the 1929 breakdown. The large increase in the public domain between 1920 and 1932 came about through the deeding of lands abandoned during this period. Even the tax lands deeded in 1933 represent almost entirely predepression delinquency. The explanation of this abandonment seems to lie in the failure of agriculture to absorb any appreciable amount of wild land during the preceding fifteen or twenty years and to the final exploitation of much of the hardwood area.

The tax-delinquency record from 1890 to 1932 (Fig. 3) gives some suggestions which are of interest in relation to the present problems. In lower Michigan the delinquency of the northeast region (*D*) was heavy in the 'nineties and reached an enormous peak

in 1902 Presumably this signified the early abandonment of the pinelands, which were far more extensive in the northeast than elsewhere A similar, but much less striking, rise is illustrated in the northwest region (C), where the pine areas were relatively smaller. The definite, but slightly lower, peaks in the western and eastern upper peninsula (A and B) appear in almost exactly the same period

During the succeeding decade delinquency is uniformly low in all the regions The problem apparently had disappeared The flattening of the curve of rise in the 'twenties in the northeast may point to a final adjustment of the problem, and the 1938 tax-sale maps show considerable evidence that such is the case The strong interest in oil possibilities here may, however, be an important factor in reducing recent delinquencies The great and steady increase in the northwest represents, first of all, the extensive abandonment of hardwood areas, in which the commercial timber values or speculative farm potentialities or even established agricultural utilization seemed hopeless These, of course, are money values, and it is quite probable that in the northwest, where recreational subdivision had been especially active, the large money delinquencies involved in such properties tend to accentuate the curve

In the Upper Peninsula two differences are evident The first is the flattening off in the eastern part (B) after 1927-28, the second is the earlier appearance of the flood of delinquencies in this area Enough lands had passed through the five-year period in the east to cause a major amount of deeding to the state prior to 1932 In the west (A) the moratorium after 1932 occurred just at the beginning of a period of great tax delinquency Hence the accumulation represented in the 1938 tax-sale map is far greater in the west. The only exception is in the vast reversion in Luce County. This is due to certain peculiarities in the ownership of very large tracts which prevented abandonment for a few years and postponed most of the delinquency to the 1938 sale.

The tax-sale maps for 1938 (Figs 1-2) show an area of approximately two million acres headed for state ownership unless there are changes in the tax laws The great volume of such land is due to the accumulation which normally would have been distributed over six tax sales Doubtless the effect of the depression has been to increase delinquency, but if the graph for 1920 to 1930 were continued it would reveal no more than a normal progression to 1938. It ap-

pears that the factors which began to operate in 1920 have been continuing in about the same manner

On the basis of the patterns shown in the 1938 tax-sale maps certain definite trends in the expansion of the public domain may be suggested (1) In many of the old pine areas in the Lower Peninsula, where tax delinquency ran highest in the early days, the process has nearly run its course, and a balance seems to have been struck between public and private ownership (2) The better farm areas have maintained themselves and are not much afflicted by delinquency (3) Several marginal farm areas have declined and are becoming tax-delinquent These were originally hardwood lands located for the most part in the western part of the Lower Peninsula Apparently they require new appraisals in terms of future use (4) Several areas of excessive delinquency occur in the Upper Peninsula in sections previously quite immune to the process This appears to be a belated recognition of the same factors which have been operating in the Lower Peninsula, possibly with a considerable abandonment of speculative mineral holdings in the west Many interesting patterns in small areas suggest the value of detailed analysis and correlation with other known distribution patterns

During the past fifteen years much experience has been gained in the operation of the public domain, and great advances have been made Fire control and prevention have been perfected It is now generally agreed that the action of the legislature in establishing an agency to administer a permanent and probably increasing portion of the area of the state was wise and effective The state forests, the game areas, the state parks, and other units of the public domain have become an established part of Michigan's wealth and resources The 1938 tax-sale maps may have some value in pointing out the probable future direction of expansion and in providing base data for planning the public use of such areas.

UNIVERSITY OF MICHIGAN



# **GEOLOGY**





# SURFACE GEOLOGY OF MONTMORENCY COUNTY, MICHIGAN

STANARD G. BERGQUIST

## GENERAL CONSIDERATIONS

**M**ONTMORENCY COUNTY is in the northeastern portion of the Lower Peninsula of Michigan. It forms a part of the physiographic unit commonly referred to as the northern upland and lies about twenty-five miles directly west of Thunder Bay (Fig. 1).

The area was covered by the Huron lobe of the Labrador ice sheet, which deployed over the region of the Great Lakes during the Pleistocene epoch. Upon retreating from the county the ice left in its wake a large amount of debris, which was spread out as a drift cover to bury completely the preglacial rock surface. The thickness of the glacial drift ranges from 100 feet in the northeastern corner of the county to over 800 feet in the southwestern portion (Fig. 2).

The surface expression of the county is characterized by a series of morainic ridges interspersed with trains of gravel and sand and occasional plains of till or boulder clay. The topography grades from rough and rolling in the morainal areas to smooth and level in the overwash plains. The general elevation of the terrain ranges from 1,300 feet in the high morainic uplands to slightly less than 800 feet in the valley of Thunder Bay River, where it leaves the eastern edge of the county near Hillman.

## DRAINAGE

Montmorency County is a region of extremely youthful drainage. The large volume of melt water draining off from the ice front in its retreat was responsible for the development of a number of small and aimless streams. The haphazard character of the drainage is exemplified in the numerous swamps and lakes scattered over the surface.



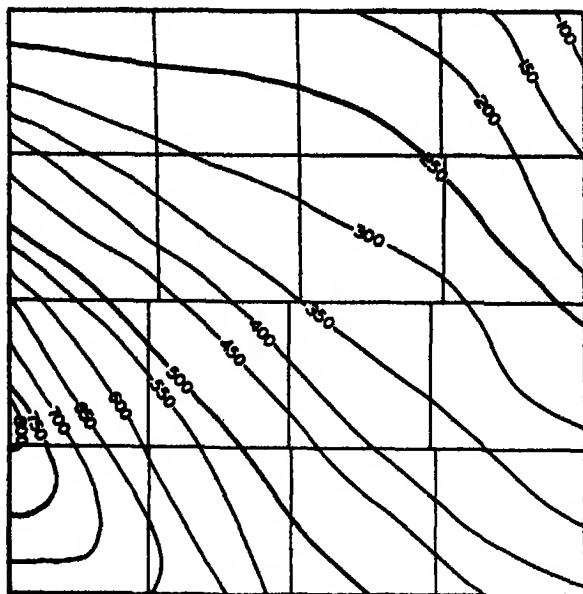


FIG. 2 Isopach map showing thickness of glacial drift in Montmorency County (after Michigan Geological Survey map compiled by James Akers)

Streams are poorly developed, and the drainage pattern is not at all systematic. To a large extent the smaller streams are concentrated in the valley trains between the morainal ridges and flow across floors of pervious sand and gravel, which permit downward percolation. In those areas where clay deposits form the valley bottoms or immediately underlie the gravel at shallow depths the streams are usually fringed with poorly drained swampy lowlands.

After the final retreat of the ice from the county innumerable gullies have developed on the stronger slopes of the moraines. The higher uplands are being thoroughly cut up by rainwash dissection. By selective transportation the finer sediments are carried down slopes and the coarser sediments are being concentrated in the incipient valley ways.

#### ICE ACTIVITY

##### *Moraines*

The main ridge of the Port Huron morainic system cuts diagonally across the southwestern corner of Montmorency County. While

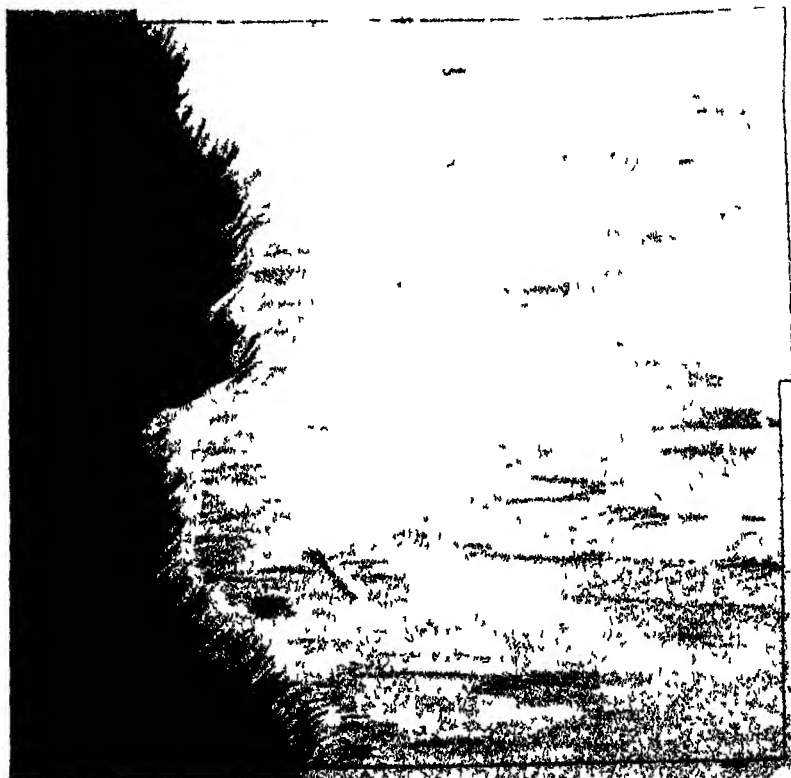


FIG 3 The first stage of retreat of the Huron lobe in Montmorency County

this moraine was being constructed the ice front, in its last stand as a continuous mass, rested on the border of the ridge at its contact with the Lewiston outwash plain

When the ice on the main ridge of the Port Huron system started to break up in the interlobate area directly north of Gaylord in Otsego County the Michigan lobe retired in a westerly direction. Simultaneously the ice in the Huron lobe began a retreat to the east. In its back stepping to the Lake Huron basin this lobe stopped at intervals to lay down a succession of five distinct more or less parallel finger-like morainic ridges trending north and south across Montmorency County



FIG 4 The second stage of retreat of the Huron lobe

At their southern ends these ridges are tied in directly with the main moraine of the Port Huron system. This confluent relationship would seem to indicate that the eastward-retreating ice front was pivoted in the ice mass which had been responsible for the development of this moraine. Thus it is logical to assume that the main axis of the Port Huron morainic system east of the interlobate area came out of the ice in piecemeal units. It developed, not as an extended and integrated ridge by northeastward retreat of the glacier, but rather in small segments controlled in development by the retirement of the Huron lobe to the east (Figs 3-7).



FIG 5 The third stage of retreat of the Huron lobe

#### TILL PLAINS

Areas of till plains are not extensively developed in Montmorency County. Such plains of boulder clay as were formed on the retreat of the ice from the position of one moraine to the next were in large measure buried under glaciofluvial and glaciolacustrine sediments carried out by melt waters from the receding ice front. Aside from the Hillman plain, which occupies some forty square miles in the northeastern section of the county, the till-plain areas occur merely in small isolated patches as outliers projecting through the glaciofluvial floors of the valley ways.

The Hillman plain comprises almost a complete unit within



FIG 6 The fourth or final stage of retreat of the Huron lobe

Montmorency County. It extends eastwardly very slightly into Alpena County. It is a relatively level plain of a fairly heavy till composed largely of boulder clay. A few small eskers and several kames are scattered through the plain, but they are features of minor importance.

#### MELT-WATER ACTIVITY

##### *Border Drainage — Valley Trains*

At each halt of the ice in its retreat eastward across the county melt-water activity was concentrated along the outer margin of the ice sheet. The intermorainic till plains, formed by the rapid



recession of the ice front from one ridge to the next, were largely overwashed with gravel and sand deposited by the border streams. Thus there was developed between the moranic ridges a series of valley trains composed in the main of stratified gravel and sand.

The strong transverse ridge of the Port Huron moraine served as a barrier to the southward expansion of the border drainage ways and caused considerable ponding of the excess melt water in the southern ends of the valleys. Into these ponded basins there was carried a great deal of sediment, which was banked up against the inner slopes of the moraines and distributed generally over the valley floors.

In those areas where the water was dammed back for relatively long intervals during the occupancy of the ice on the moraines much fine sediment in the form of stratified clay and silt was sorted out and deposited in the ponded waters. The clay in these deposits is reddish, plastic, and tight. In many places it is interstratified with silt and sand and occasionally exhibits evidence of fine lamination.

The glaciolacustrine sediments vary considerably in thickness, as is evidenced by the records of several wells drilled in the county. Along the border of Hunt Creek in the northeastern corner of Section 17, T 29 N, R 3 E, a well 75 feet deep encountered a surface layer of 7 feet of yellow sand over a deposit of red clay 65 feet thick. The clay in this area rests on a brown stratified sand and gravel. A well in the swampy tract of Section 34, T 32 N, R 4 E, is reported to have penetrated 114 feet of red lacustrine clay resting directly on gravel. In the gravel plain two miles east of Atlanta in Section 8, T 30 N, R 3 E, a well 80 feet deep went through 79 feet of reddish lacustrine clay above a bed of gravel. The surface of the clay deposit in this area is covered with a thin veneer of fine-textured yellow sand. The Gilchrist No. 1 well, drilled in the lake plain area in the SE  $\frac{1}{4}$ , SW  $\frac{1}{4}$ , Section 12, T 29 N, R 3 E, went down to bedrock through 335 feet of alternating beds of red clay and water sand. In the lake plain area on the Thunder Bay River at Hillman 90 feet of alternating beds of sand, red clay, and gravel were revealed in drilling.

From the thickness of these clay deposits it may well be inferred that ponded conditions prevailed in the valley ways for relatively long intervals of time. The amount of sedimentation reflected in

# MONTGOMERY COUNTY



DEPARTMENT OF CONSERVATION  
LAND ECONOMIC AND GEOLOGICAL SURVEY  
BUREAU OF GEOLOGY  
SURFACE AND HARD ROCK FORMATIONS  
OF  
MONTGOMERY COUNTY

1:25,000

## KEY TO MAP SURFACE FORMATIONS

	ALLUVIUM
	TILL PLAIN OR OTHER DEPOSITS
	CLAYEY SOIL
	SANDY PLAIN
	HARD ROCK FORMATIONS
	UNCONSOLIDATED MATERIAL BETWEEN ROCK FORMATIONS
	DIKES
	FAULTS
	LIGNITE
	PAVED HIGHWAYS
	ELEVATIONS BASED ON 1916

FORMATION MEMBER	DESCRIPTION AND ECONOMIC RESOURCES
LOWER MARSHALL SANDSTONE	1. 10' to 15' thick, composed of yellowish sandstone, with some shales and thin layers of coal. It is a good source of sand and gravel. 2. 10' to 15' thick, composed of yellowish sandstone, with some shales and thin layers of coal. It is a good source of sand and gravel.
COLEMAN SHALE	1. 10' to 15' thick, composed of yellowish sandstone, with some shales and thin layers of coal. It is a good source of sand and gravel. 2. 10' to 15' thick, composed of yellowish sandstone, with some shales and thin layers of coal. It is a good source of sand and gravel.
SHARP SHALE	1. 10' to 15' thick, composed of yellowish sandstone, with some shales and thin layers of coal. It is a good source of sand and gravel. 2. 10' to 15' thick, composed of yellowish sandstone, with some shales and thin layers of coal. It is a good source of sand and gravel.
ANTWERP SHALE	1. 10' to 15' thick, composed of yellowish sandstone, with some shales and thin layers of coal. It is a good source of sand and gravel. 2. 10' to 15' thick, composed of yellowish sandstone, with some shales and thin layers of coal. It is a good source of sand and gravel.
TRINITY Limestone	1. 10' to 15' thick, composed of yellowish sandstone, with some shales and thin layers of coal. It is a good source of sand and gravel. 2. 10' to 15' thick, composed of yellowish sandstone, with some shales and thin layers of coal. It is a good source of sand and gravel.

Fig 7



the intermorainic valleys should possibly afford a clue to the relative length of time involved in the construction of the several recessional moraines

Of unusual interest to the student of glacial geology is the small area of deeply pitted valley train in the region of Scotty Lake in T 32 N, R 2 E. The pits in this section are surface expressions of sink holes developed in the underlying Traverse limestone. They are lined up with the sinks in the Shoepac Lake country of Presque Isle County described by Poindexter.<sup>3</sup>

The caving of the limestone to form the Karst topography undoubtedly took place before the advent of Pleistocene glaciation. In the process of building up the valley train deposit either the melt waters were unable to carry in sufficient sediment to level up completely the surface before retreat of the ice sheet or some of the material was carried away by subterranean streams during or after deposition. The preglacial basins were thus left as partly filled pits when the ice finally disappeared.

#### OUTWASH PLAINS

Aside from the valley-train deposits distributed between the recessional moraines the only extensive piece of outwash in the county is the Lewiston plain in the southwestern corner. This outwash was laid down by melt waters draining out from the ice front during the construction of the main ridge of the Port Huron morainic system. It is merely a part of the extensive plain that continues into Oscoda and Wexford counties farther south.

In the Lewiston area the plain is composed of sorted and stratified gravel and coarse sand. The surface of the plain is relatively level, except in the pitted areas. Many of the pits are occupied by lakes such as East Twin, West Twin, Big Wolf, Little Wolf, Spectacle, and Crystal.

#### GAS SEEPS

Along the marshy borders and bottoms of several of the streamways, namely, Miller, Gilchrist, and Hunt creeks, and also the Thunder Bay River near Atlanta, there are numerous seeps of

<sup>3</sup> Poindexter, O. Floyd, "Sinkholes in the Indian Lake Region, Schoolcraft County, and Other Michigan Sinks," *Pap. Mich. Acad. Sci., Arts, and Letters*, 21 (1935) 440-442. 1936.

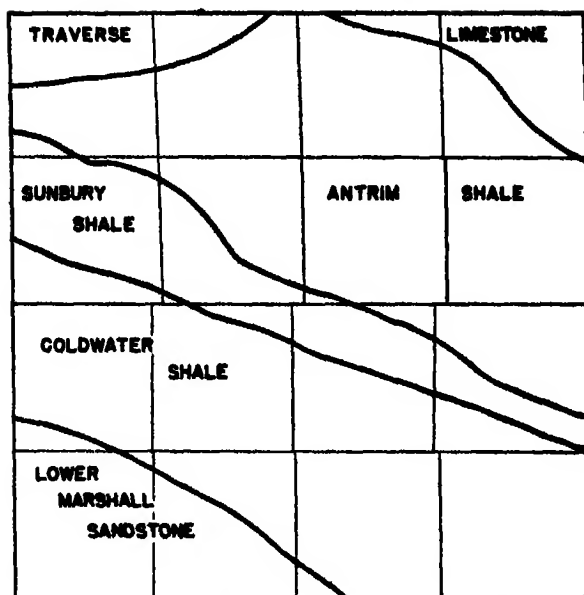


FIG 8 Areal distribution of formations in Montmorency County (after the Centennial Geologic Map of the Michigan Geological Survey)

natural gas. In places the gas is emitted in volume sufficient to be ignited and may burn for many hours before becoming exhausted. In certain areas it boils up through the water under pressure so great that quantities of fine silt and clay are carried upward to form cones which measure five to six feet in height and up to eight and ten feet in diameter at the base. Many of the seeps are extremely active, and the gurgling gas churns the fine sediments into a milky white suspension.

The deposits in which the gas seeps occur are underlain by shale of the Antrim, Sunbury, and Coldwater formations (Fig. 8). These shales, especially the Antrim and the Sunbury, are usually dark and contain appreciable amounts of carbonaceous material, the decomposition of which is undoubtedly responsible for the production of the gas.<sup>4</sup> Eardley<sup>5</sup> contends that the gas has its origin in a middle gas

<sup>4</sup> Newcombe, Robert B., "Oil and Gas Fields of Michigan," *Mich. Geol. and Biol. Surv.*, Publ. 38, Geol. Ser. 32, p. 77. 1939

<sup>5</sup> Eardley, Armand J., personal communication

horizon contained in the Antrim shale and that the largest seeps occur in those areas nearest the edge of the contact with the overlying formation.

#### CONCLUSION

A field study of surface features seems to bear out the view that the ice sheet responsible for the deposition of the main ridge of the Port Huron morainic system in Montmorency County retreated eastward in a series of short halts during the interval of its construction. This conclusion is emphasized in the north-south trend of the minor ridges which lie inside the main moraine in this area and also by the fact that they are attached directly to the axis of the principal moraine.

MICHIGAN STATE COLLEGE  
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## ROUNDNESS OF GRAINS IN WESTERN MICHIGAN DUNE SANDS

JAMES LEWIS CALVER

MUCH has been written on the size and the shape of grains of sand. This study is an attempt to discover the amount and the rate of rounding that has taken place in the dune sands in relation to the distance the grains have been blown by the wind. Cressey suggested that the frosted appearance of such sands is "the distinguishing criterion of eolian action"<sup>1</sup>. The amount of frosting was studied, but the investigation of this characteristic was later abandoned because it appeared to be very likely that frosting is part of the rounding process, since it was found in beach as well as dune sands. Although there is an increase in the number of frosted grains in dune sands in relation to the distance the sand has been moved by the wind, the frosting was evident only on grains having rounded surfaces.

During the fall of 1937 samples of sand were collected from three dunes on the east shore of Lake Michigan, in the vicinity of Grand Haven, Michigan. Dune I, the longest dune studied, is one mile north of the mouth of the Grand River. The length of this dune from the present lake shore to its apex, which rises about 140 feet above lake level, is 4,600 feet. Dune II, Rosy Mound, lies two and one-half miles south of Grand Haven, it is 4,200 feet in length, and its apex rises to a height of 240 feet. Dune III is eleven miles south of Grand Haven, just north of Port Sheldon. It is 2,800 feet long, with its apex 120 feet above lake level. These dunes were chosen for study because very little vegetation was growing on them.

Duplicate samples of sand were collected at measured intervals from the lake shore to the apex of each dune. Care was exercised to select only recently blown sand on the dune surface, and from a

<sup>1</sup> Cressey, George Babcock, *The Indiana Sand Dunes and Shore Line of the Lake Michigan Basin* (The Geographic Society of Chicago, Bulletin No. 8), p. 31. Chicago, [1928].



depth of not more than one-half inch. The distance between the stations at which samples were taken was measured by chaining with a hemp rope one hundred feet in length

A petrographic analysis of sand occurring in the dune one mile north of Grand Haven showed the presence of the following minerals quartz, orthoclase, microcline, magnetite, garnet, green hornblende, leucoxene, ilmenite, limonite, calcite, and epidote. Quartz, which is by far the most abundant, comprises over 93 per cent of the sand.

In determining the amount of roundness the qualitative method described by Russell and Taylor in their paper on Mississippi River sands<sup>2</sup> was employed. Although they found the method not so accurate as the quantitative one used by Wadell,<sup>3</sup> the results appear to be comparable, as for the visual-classification method, errors due to personal judgment are too small to affect the results seriously.

A mechanical analysis was made of all samples of sand used (about 220 grams in each), and the sand was separated into groups of the following diameters:  $> 1$  mm.,  $1 - \frac{1}{2}$  mm., and  $< \frac{1}{2}$  mm. Ten grams of sand finer than  $\frac{1}{2}$  mm. in diameter were then separated into groups of  $\frac{1}{2} - \frac{1}{4}$  and  $< \frac{1}{4}$  mm. The sieves employed were made by the Central Scientific Company of Chicago, Illinois; they were shaken by hand. The results of the analysis are shown in Table I. Inasmuch as approximately 80 per cent of the sand falls into the  $\frac{1}{2} - \frac{1}{4}$  mm. group, only this sand was used in determining the amount of rounding.

On the average 467 grains were taken from this group for each sample studied and were examined under a binocular microscope. All opaque grains were separated and excluded from consideration; this procedure left about 420 grains to be classified, as follows: angular, subangular, subround, and round. The round and the angular grains were separated first, and the remainder of the sand was later divided into the subround and subangular groups.

The grains that showed no apparent wear and had sharp edges and sharp corners were called angular. Those in which the original form was evident and which appeared to have worn corners and edges were considered subangular. Those that had a rounded sur-

<sup>2</sup> Russell, R. Dana, and Taylor, Ralph E., "Roundness and Shape of Mississippi Sands," *Journ. Geol.*, 45: 225-287. 1937.

<sup>3</sup> Wadell, H., "Volume, Shape, and Roundness of Rock Particles," *Journ. Geol.*, 40: 442-451. 1932; "Sphericity and Roundness of Rock Particles," *ibid.*, 41: 310-331. 1933.

TABLE I  
SIZE FREQUENCY OF DUNE SANDS EXPRESSED IN PERCENTAGES

Sample	Percentages of size groups				Total per cent
	> 1 mm	1- $\frac{1}{2}$ mm	$\frac{1}{2}$ - $\frac{1}{4}$ mm	< $\frac{1}{4}$ mm.	
Dune I					
Beach	0 47	15 84	71 55	10 81	98.67
2,200 ft	0 03	2 48	74 40	21.50	98 41
3,400 ft	0 14	2 38	87 82	9 75	100 09
4,600 ft	0 13	4 18	81 38	13 39	99 08
Dune II					
Beach	0 00	1 13	65 46	31 59	98 18
2,200 ft	0 05	2 65	84 00	13 43	100.13
3,400 ft	2 73	6 38	79 09	11 36	99.56
4,200 ft	0 06	5 79	88 50	5 18	99 53
Dune III					
Beach	0 00	3 82	76 46	19 23	99 51
2,200 ft	0 19	3 03	83 42	13 37	100 01
2,800 ft	0 00	4 13	83 89	11 98	100 00

face, with some of the original shape of the grain still visible, were regarded as subround. The ones that had no areas of the original grain distinguishable and possessed a smooth and, frequently, a completely frosted surface were called round. A few grains with freshly broken surfaces were arbitrarily placed in the angular group, even though the rest of the grain was subround or even round.

The method of securing the roundness values is the same as that used by Russell and Taylor<sup>4</sup>. The number is found by multiplying the frequency percentage of grains in each roundness group by an arbitrarily assigned number, as follows: angular, 1; subangular, 2; subround, 3; and round, 4. The products are then totaled and divided by 100. An example is given in Table II (p. 468). The roundness number obtained, 1.67, indicates that the mean degree of rounding of the sample is two thirds of the way between angular and subangular.

The accuracy of the data was tested in the following way. The grains from one sample were entirely reclassified three weeks after

<sup>4</sup> *Op. cit.*, p. 238

TABLE II

THE METHOD FOR FINDING ROUNDNESS VALUES OF SAND GRAINS AS  
ILLUSTRATED BY SAMPLE 1 FROM DUNE I

	<i>No of grains</i>	<i>Percentage</i>
Angular	320	$55.6 \times 1 = 55.6$
Subangular	147	$25.5 \times 2 = 51.0$
Subround	86	$14.9 \times 3 = 44.7$
Round	23	$4.0 \times 4 = 16.0$
		$\frac{167.3}{100} = 1.67$

the first determination, the difference in the roundness values was 0.016. A complete test was run with a duplicate sample also. The mechanical analysis was essentially the same, and the roundness value was 0.012 less than the first number determined.

The roundness values found in this study are listed in Table III, and are also plotted on a graph in Figure 1. The first point of each curve represents sand taken from the beach where the waves were still working the material. The difference in these roundness values is explained by the fact that the samples were collected from different localities. Some local variation in the beach sand at Rosy Mound probably accounts for the low value of the first point in Dune II.

TABLE III

ROUNDNESS OF SAND GRAINS

1 = angular, 2 = subangular, 3 = subround, 4 = round

<i>Distances from Lake Michigan</i>	<i>Dune I</i>	<i>Dune II</i>	<i>Dune III</i>
Beach	1.67	1.53	1.84
2,200 ft	1.71	1.69	1.90
2,800 ft			1.92
3,400 ft	1.77	1.73	
4,200 ft.		1.77	
4,600 ft	1.84		

When the roundness values are plotted on semilogarithmic graph paper it is apparent that the rate of rounding is nearly the same in each of the three dunes studied (see Fig. 2). It is evident that this rate in wind-blown sands is an exponential function. In a recent

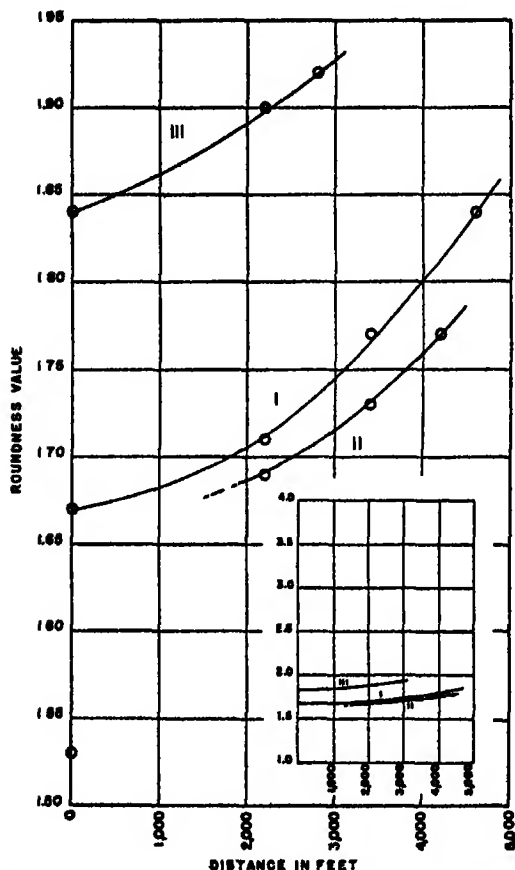


FIG 1 Average roundness of dune sands near Grand Haven, Michigan

paper Krumbein showed that several sedimentary problems could be studied mathematically.<sup>5</sup> The problems with which he worked were: pebble size on a beach, the thickness of a loess deposit, the profile of an alluvial fan, and the dispersion of glacial boulders in a boulder train. In each he found that an exponential function is involved.

The data used in this study of roundness of dune sands can be treated mathematically also. The distance in feet the sand grains

<sup>5</sup> Krumbein, W. C., "Sediments and Exponential Curves," *Journ. Geol.*, 45: 577-601, 1937.

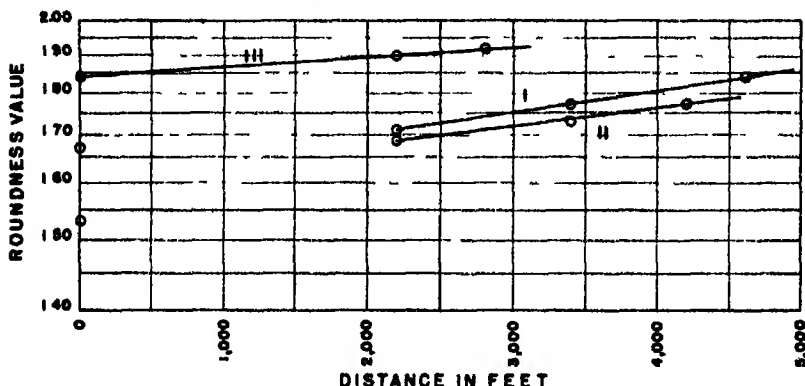


FIG 2 Semilogarithmic graph of average roundness of dune sands near Grand Haven, Michigan

have been blown by the wind is the independent variable,  $x$ , and the amount of rounding of the grains is the dependent variable,  $y$ . Since  $y$  increases geometrically as  $x$  increases arithmetically, the relation between the variables is called an exponential function and is expressed by the formula  $y = mb^{ax}$ . The constant  $m$  is the value of  $y$  when  $x$  equals 0, the constant  $b$  is the base of the exponential function, and  $e$ , the base of natural logarithms, is here chosen, the constant  $a$  is the coefficient of  $x$ .

By substituting the values from Dune III in the equation and solving, the constant  $a$  is found to have the approximate value  $15 \cdot 10^{-6}$ . This value is the *coefficient of roundness*; consequently the formula for the increase in rounding of wind-blown sand in the dune is  $y = 1.84e^{15 \cdot 10^{-6}x}$ . In Dunes I and II, by moving the  $y$ -axis to the 2,200-foot point and neglecting the points at the beach, and drawing straight lines through the points, the constant  $a$  has the following approximate values: for Dune I  $a = 29.5 \cdot 10^{-6}$ , and for Dune II  $a = 21.5 \cdot 10^{-6}$ . It would seem that the general law governing the rounding of sand grains in the area studied would be close to the average of these values, that is,  $y = me^{22.5 \cdot 10^{-6}x}$ . If this average value is used for  $a$  the straight lines can be drawn through the points already determined (Fig 3).

Several factors may affect the roundness of dune sands: the angle of the windward slope of the dune, the velocity of the wind, the amount of vegetation on the dune surface, the degree of inherited

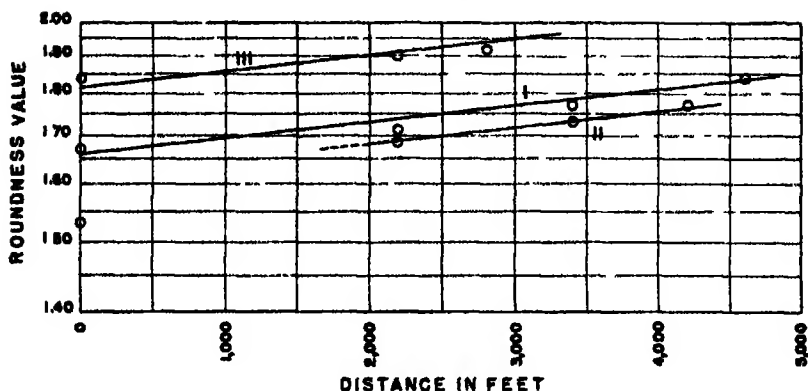


FIG 3 Corrected semilogarithmic graph of average roundness of dune sands near Grand Haven, Michigan

roundness, and others. In the sands of Dune III the apparent variation from the average rounding may be explained by one or more of these factors.

#### CONCLUSIONS

More than 93 per cent of the sand in the dunes studied is quartz, and at least ten other minerals make up the remaining fraction.

About 80 per cent of the grains in the dune sands near Grand Haven, Michigan, have diameters between  $\frac{1}{8}$  and  $\frac{1}{4}$  mm.

The rate of rounding of dune sand is an exponential function and was determined as  $y = me^{2.5 \times 10^{-4}x}$ .  $y$  is the amount of rounding expressed in an index number;  $x$  equals the distance in feet over which the sand has been blown;  $m$  is the value of  $y$  when  $x$  equals 0, and  $e$  is the base of the function.

Twenty per cent of the grains in dune sands which have traveled between 4,200 and 4,600 feet from the shore of the lake show *some* rounding which may be attributed to eolian activity. The increase in the average roundness produced during this transportation by the wind is so small, however, as compared with the inherited roundness, or the amount of roundness possible, that it cannot be used as a criterion to differentiate dune sand from beach sand.

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## SOME EXAMPLES OF VENTIFACTS FROM SLEEPING BEAR POINT, LEELANAU COUNTY, MICHIGAN

KENNETH W DOW

**W**IND-CUT pebbles occur, often in association with the perched dunes, at many points along the eastern shore of Lake Michigan. Some of the finest of these *Windkanter* may be found on the high wind-swept morainic plateau known as Sleeping Bear Point, in western Leelanau County, Michigan. The existence of ventifacts at this location was first noted by Winchell,<sup>1</sup> in 1886. With the exception of brief allusions, by Waterman<sup>2</sup> in 1926 and by the author<sup>3</sup> in 1937, no further mention of them has been made and no illustrations have ever been given. The purpose of the present paper is not only to illustrate the standard forms but also to describe briefly a few of the unusual wind-cut stones that have been found by the writer on Sleeping Bear Point.

Since the time of Blake,<sup>4</sup> who was one of the first to note the phenomenon, much has been written on the cutting of pebbles by wind action. As Woodworth<sup>5</sup> remarked after observing this process on Martha's Vineyard in 1894, "There can be no question that sands driven by the wind have the power to cut away the surface of rocks on which they impinge. Views at present differ only concerning the manner in which these planes were cut." Views still differ as to the exact method of formation; the work of the various authors has been

<sup>1</sup> Winchell, Alexander, *Geological Studies, or Elements of Geology for High Schools, Colleges, Normal and Other Schools*, p 284. Chicago, 1886

<sup>2</sup> Waterman, Warren G., "Ecology of Glen Lake and Sleeping Bear Region," *Pap Mich Acad Sci, Arts, and Letters*, 6 (1926) 355-1927

<sup>3</sup> Dow, Kenneth W., "The Origin of Perched Dunes on the Manistee Moraine, Michigan," *Pap Mich Acad Sci, Arts, and Letters*, 23 (1937) 438-1938

<sup>4</sup> Blake, William Phipps, "On the Grooving and Polishing of Hard Rocks and Minerals by Dry Sand," *Am. Journ. Sci.*, 20. 178-181 1855.

<sup>5</sup> Woodworth, J. B., "Post-glacial Eolian Action in Southern New England," *Am. Journ. Sci.*, 47: 64. 1894



admirably summed up by Bather <sup>6</sup> and, more recently, by Bryan <sup>7</sup> The general consensus of opinion regarding small rocks tends to the belief that the shape is determined by the cutting of a surface at right angles to the wind rather than that individual facets are caused by a splitting or dividing of the wind as it passes over the rock In this paper the classification of Bryan <sup>8</sup> is followed He divides wind-faceted stones into four main types (1) ridge-shaped, (2) triquetrous, (3) pyramidal, and (4) irregular Examples of the first three types, which may be called standard forms, are commonly found on Sleeping Bear Point

### 1 Ridge-shaped type

In Plate I, Figure 1, the pebble in the upper left-hand corner displays a single broad flat facet The specimen in the upper right-hand corner is a more highly developed example of this type, in which two facets are inclined toward each other to form a ridge, with other facets existing at one or both ends

### 2 Triquetrous type

At either end of the bottom row in Plate I, Figure 1, are stones which verge on the triquetrous or "Brazil-nut" shape, transition forms from the ridge type This triquetrous shape, commonly found in small elongated pebbles, is the result of erosion around the base, with forward overturning of the pebble to expose a fresh surface to the wind

### 3 Pyramidal type

A typical illustration of the pyramidal type is given in the bottom row, center, of the same figure In this instance six facets converge toward a common point to form a rough pyramid The small flat area in the middle may represent a remnant of the original top surface

### 4 Irregular type

The ventifact in the top row, center, of Plate I, Figure 1, because of the peculiar hollowed facet, would be classed as "irregular" The hollowing may have resulted from diffission or from the chipping off

<sup>6</sup> Bather, F. A., "Wind-worn Pebbles in the British Isles," *Proc. Geological Assn.*, 16: 396-420, Pl. 11. London, 1900.

<sup>7</sup> Bryan, Kirk, "Wind-worn Stones or Ventifacts — a Discussion and Bibliography," *Rep. Committee Sedimentation for 1929-30*, Nat. Res. Council Rep. and Circ., Ser. No. 98: 29-50. 1931.

<sup>8</sup> Bryan, *op. cit.*, p. 31.

of a fragment. On the under side of the rock, however, is a distinct oval depression, and the hollowed facet on the upper surface is undoubtedly a reworking and polishing by the wind of a similar feature. It should be noted that the original form of the pebble often influences the shape of the wind-cut surface.

A most unusual ventifact of the irregular type is shown in Plate I, Figure 2. The outer portion of this rock, which is basaltic in character, appears to differ slightly from the core in hardness. The specimen seems to be not an example of a desert rind such as is described by Hobbs,<sup>9</sup> but, rather, the result of exfoliation — aided by a natural local variation in the constituents of the rock — with subsequent unequal cutting by the wind.

Plate II, Figure 1, shows another interesting product of wind action. Facets have been cut by the wind on a rather large glacial boulder without completely obliterating a series of crescentic cracks, or gouges, which have all the appearance of being a form of chatter mark. Chatter marks are usually found on a bedrock surface rather than on a loose boulder (see Chamberlin<sup>10</sup> or Russell<sup>11</sup>). If these cracks are chatter marks, however, the rock offers an unusual illustration of the results of the abrasion of a rock surface by two agents completely different in character — wind and ice. For comparison an example of genuine chatter marks from the Holland Quarry near Sylvania, Ohio, is given in the lower right-hand corner of Plate II, Figure 2.

Many forms of wind-cut rock in addition to the faceted types described are found on the plateau at Sleeping Bear Point. Typical of these wind-scoured, or wind-shaped, stones are the specimens shown in Plate II, Figure 2. The softer rocks are likely to exhibit pitting. Scouring along bedding planes occurs, and, as is evident in the illustration, fluting may be found in both the soft sandstones and the more resistant basaltic forms. There may also be undercutting, as in the largest specimen in this figure, a piece of red quartz-

<sup>9</sup> Hobbs, William Herbert, "The Peculiar Weathering Processes of Desert Regions, with Illustrations from Egypt and the Soudan," *Ann. Rep. Mich. Acad. Sci.*, 20: 96, 1918.

<sup>10</sup> Chamberlin, T. C., "The Rock-Scorings of the Great Ice Invasions," Dept. Int., *Ann. Rep. U. S. Geol. Surv.*, pp. 247-248, 1886.

<sup>11</sup> Russell, Israel C., "A Geological Reconnaissance along the North Shore of Lakes Huron and Michigan," *Ann. Rep. Geol. Surv. Mich.* (1904), pp. 64-65, 1905.

ite, or harder veins in a rock may be brought into relief, as in the specimen just to the left of the fragment showing chatter marks

Excellent examples of unusual wind-worn stones as well as of standard types may still be found on Sleeping Bear Point, Leelanau County, Michigan. If, as is believed, the shape is determined primarily by the cutting of a surface at right angles to the wind, the general orientation of the wind-cut pebbles on Sleeping Bear Point would indicate winds predominantly from the southwest. Owing to the growing popularity of Sleeping Bear Point as a recreational area in recent years, however, and to its increased accessibility through the use of motor cars on the plateau surface, good wind-worn pebbles will soon become scarce. It is for this reason that a description of them is presented while they may yet be observed in considerable variety.

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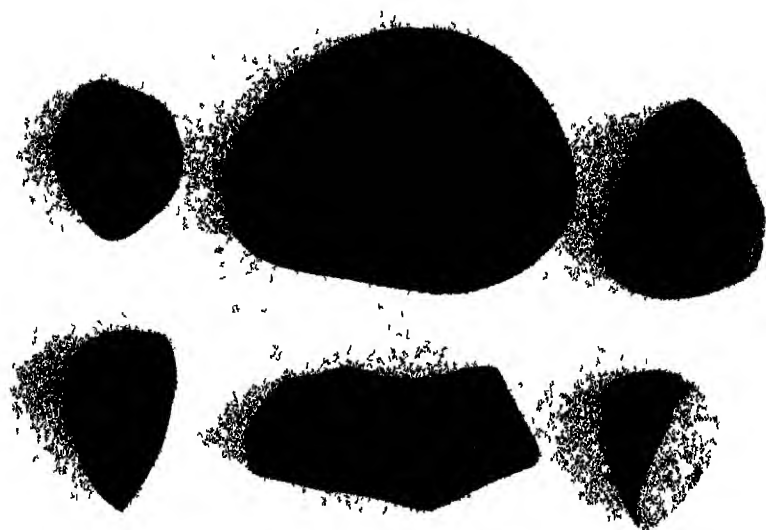


FIG 1 Typical ventifacts from Sleeping Bear Point, Leelanau County, Michigan  
About  $\times \frac{1}{4}$



FIG 2 Ventifact showing unequal cutting by the wind subsequent to exfoliation  
About  $\times \frac{1}{4}$





FIG 1 Ventifact with crescentic gouges or chatter marks  $\times \frac{1}{4}$



FIG 2 Wind-scoured, or wind-shaped, stones from Sleeping Bear Point. Specimen showing chatter marks (lower right-hand corner) is from Holland Quarry near Sylvania, Ohio. All specimens about  $\times \frac{1}{4}$



## CONDITIONS AT THE FRONT OF A RETREATING ICE SHEET

WILLIAM H HOBBS

**E**ARLY studies of Pleistocene continental glaciers were undertaken before existing glaciers of this type had become known. The only glaciers known were mountain glaciers of the Alpine type, and the picture of conditions as regards climate and meteorology involving accretion and wastage of the ice, its movements, and the erosional and depositional conditions were all drawn from comparison with the same source — the small glaciers of the Alpine highland.

Both in Europe and in North America, where the Pleistocene glaciers were studied within the early period, the glaciers spread out for the most part over a flat terrane and within middle latitudes. Without knowledge of the autocirculation which characterizes the air above existing continental glaciers the Pleistocene glaciers were conceived to have had meteorological conditions much the same as do those of today within the same areas. Nourishment was thought to have been derived from invading surface air currents which were compelled to give up their moisture, much as do the moisture-laden clouds when they encounter elevated land areas. The shieldlike form of the glacier was explained throughout by a sort of viscous flow which obtained within the mass.

The Pleistocene ice sheets deposited materials — moraines and drumlins — which were left behind as the ice progressively wasted, and these naturally supply data which we are unable to derive from any existing glacier, where the bed is nowhere over any large area exposed for observation. The convexly festooned pattern of the moraines, with their intervening ground moraine and covering outwash, has been splendidly worked out, as has been also the history of the postglacial lakes.

As to conditions about the front of the glacier, that is quite another story, and here the existing continental glaciers permit us to correct the traditional picture. True, the existing ice sheets lie in



very high latitudes and where they are best known are also in areas of high and rugged topography. They therefore throw even more light upon glaciation in New England than in the prairie areas.

Some of the facts which have been derived from their study are the following

(1) The wind system above these glaciers is quite unlike the traditional one for Pleistocene ice sheets — a procession of cyclones which moved over them as over the area today. It is an autocirculation (glacial anticyclone) such that all strong surface winds blow downward and outward off the glacier and onto the surrounding territory.

(2) The nourishment of the glaciers by snow is not as formerly supposed — largely peripheral and due to upwardly directed air currents — but is more central to the mass and is explained by downwardly directed currents which bring moisture from higher to lower levels.

(3) The shaping of the mass is in part at least due to the centrifugal snow broom of the glacial anticyclone, which whenever in action is carrying snow outward toward the borders, so that the annual snow increment of the glacier thickens at an accelerating rate toward the margin, where it may even be piled up as marginal masses banked against the front.

(4) All relatively rapid internal movements of the glacier are restricted to the outer fifty miles, wherein the surface slope is sufficiently steep to induce movement.

(5) Melting and wastage of the ice and glacial and extraglacial water flow are restricted to the short summer season and respond quickly to the changes in air temperature from day to day. At such times huge blocks of ice from the glacier front are transported as bergs by the braided streams of the outwash, and these may support large boulders, which become either wholly or completely embedded in the sand plains outside the glacier front.

(6) At the end of the warm season the drainage ceases entirely, the extramarginal sand plains then quickly dry out, and the wind takes the place of water as a transporting agent. A glacial desert condition thus comes into existence, with the production of pebble pavements on most outwash surfaces. The sand which is lifted is carried to more sheltered areas, where it forms dunes, and the dust

is laid down over broad areas farther out to form loess deposits covered with tundra vegetation

The stranded and partially embedded boulders of the sand plains, unprotected as they are on their exposed surfaces, become deeply etched by the sandblast and are thus transformed into "anvil stones" wherever they have dikes, veins, or nodules of harder material

(7) Wherever there are outlet tongues from the inland ice and these are held within high rock walls, they become channels or "bellows pipes" for the fierce and warm outward air currents, and are wasted by melting wherever rock dust has blown on to the surface. Since melting is promoted chiefly through contact and by radiation from rock surfaces, the glacier outlet is melted down in moats next to the rock walls, and these become channels for melt-water drainage, though much choked by sand, pebbles, and even boulders derived from the melting ice. Thus there arise "kame terraces" of the sort now recognized within areas of Pleistocene glaciation which have accented topography, such, for example, as New England

(8) During the summer season the crevasses of the border zone of the glacier become the courses of drainage from the surface to the bed below, and they are in some cases so widened and extended as to separate sections of the glacier from the parent mass. This separated portion, being no longer fed by material arriving from higher levels, becomes stationary — stagnant. Examples of this were reported by the British glacialists of both of Scott's Antarctic expeditions — Ferrar of the first and Taylor of the second. The ice slabs of Ferrar, which later became the Blue, Garwood, Davis, Ward, Howchin, Miers, and Hobbs glaciers of the McMurdo Sound region in the Antarctic, all illustrate this. The great Taylor glacier, though still connected with the Ferrar glacier above it, is nonetheless stagnant. Glacialists such as Anderson, Flint, Goldthwait, and others have now tardily recognised this condition for different areas of Pleistocene ice sheets, and it is certain to assume much greater prominence in future studies.

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## A CENSUS OF MASTODON REMAINS IN MICHIGAN

ARCHIE MacALPIN

**T**WO years after Michigan became a state James Henry Lanman (1839) reported the discovery of "the remains of a mammoth" in Van Buren County. They were probably mastodon bones, if so, they constitute the first known record of such a find in Michigan. For a hundred years everything from vague rumors to authenticated reports about similar finds has trickled into the literature and correspondence. Reports reaching the University of Michigan since 1908 have been carefully preserved by Dr. E. C. Case, and those sent to Michigan State College at East Lansing have been referred to him by Dr. W. A. Kelly. Many were investigated, and parts of thirty-two of the Michigan specimens were acquired for the University Museum. Incomplete lists of discoveries of mastodons in Michigan have been made by Hubbard (1840), Winchell (1861), Lane (1902, 1906), Dice (1920), and Hay (1923), whose publications are given at the end of this article.

The one hundred and seventeen specimens listed here probably represent considerably fewer than half of those found within the state since 1839. Many fossils have been destroyed or improperly recorded because the finder was ignorant of their worth or the methods of caring for them. Mastodon bones are extremely fragile on exposure to air, so that they require expert handling to be correctly exhumed and preserved. In spite of these difficulties enough have been found to give one a hint of the vast numbers of animals that once roamed the state.

The material for this census is taken from my "Survey of the Occurrence of Mastodon Remains in Michigan," submitted in February, 1939, to the Geology Department of the University of Michigan. This list is arranged by counties in alphabetical order. The data comprise (1) numbers corresponding with those on the map to designate the sites in each county (see Fig. 1); (2) towns near

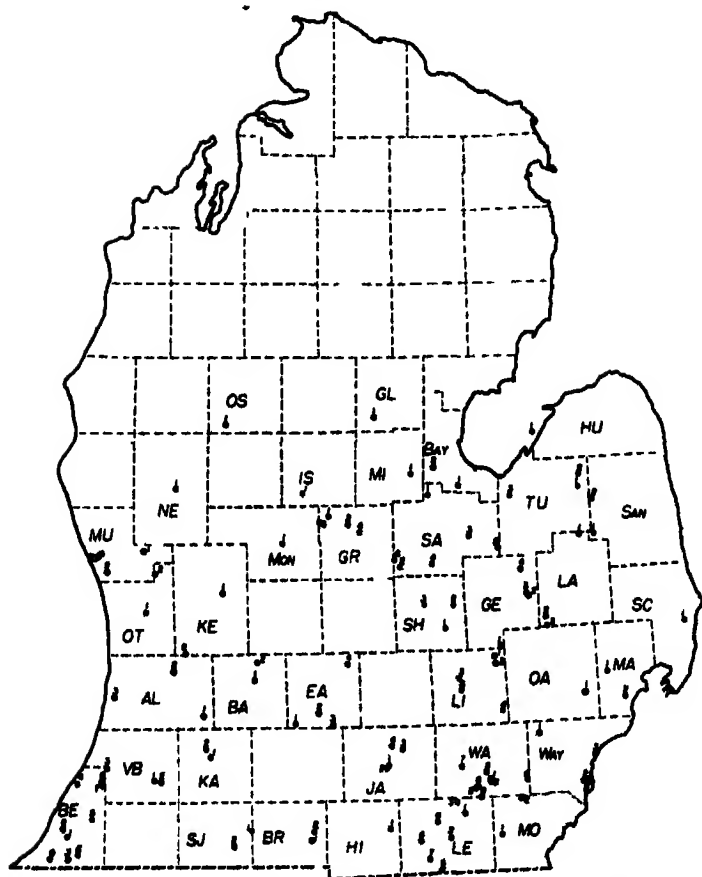


FIG 1 Distribution of discoveries of mastodon remains in Michigan

#### KEY TO COUNTIES

AL — Allegan	HI — Hillsdale	MA — Macomb	SA — Saginaw
BA — Barry	HU — Huron	MI — Midland	SAN — Sanilac
BAY — Bay	IS — Isabella	MO — Monroe	SC — St Clair
BE — Berrien	JA — Jackson	MON — Montcalm	SH — Shiawassee
BR — Branch	KA — Kalamazoo	MU — Muskegon	SJ — St Joseph
EA — Eaton	KE — Kent	NE — Newago	TU — Tuscola
GE — Genesee	LA — Lapeer	OA — Oakland	VB — Van Buren
GL — Gladwin	LE — Lenawee	OS — Osceola	WA — Washtenaw
GR — Gratiot	LI — Livingston	OT — Ottawa	WAY — Wayne

the places where remains were discovered, together with the section, township, and range, and (3) summary statements of the material found. Much more detailed information is available in the original survey, which contains, provided such information was obtainable, items (1) and (2) as just noted, (3) a complete list of the bones reported; (4) a description of the vertical section, (5) the name of the finder and the date of discovery, (6) the present location of the specimen, and (7) a bibliography of the literature, together with all the correspondence and clippings pertaining to the find that I could discover.

Though most of the finds are well authenticated, some are not traceable, and the records may be inaccurate. The Geology Department of the University of Michigan will greatly appreciate any corrections of the list and a detailed report of new discoveries. Only by the continual accumulation of accurate data can the time of these animals be defined and their habits become better understood.

No record of the embedding material or the depth of burial was available for 41 of the 117 fossils. Fifty-one specimens, or about two thirds of the remainder, were found in peat or black, mucky soil, an additional four were enclosed partly in peat and partly in marl. These muck- or peat-buried remains were from a few inches to six feet below the surface. Many of them were lying directly on sand, till, marl, or clay. Of course, the preserving quality of peat accounts largely for our being able to recover so many remains, nevertheless such a preponderance of fossils on the sites of former lakes and swamps must indicate that these lowlands were a favorite habitat of the mastodon. The other finds were buried in sand, gravel, or silt of present streams, and marl of present or recently extinct lakes. A number of remains were at greater depths, bones in river deposits were from 7 to 15 feet deep, those in the lake marls about 20 feet, and a few in sand and gravel of undetermined origin from 1 to 30 feet. I have been unable to visit the sites of these discoveries, so that this information is based almost entirely upon the records available.

Except for three or four scattered localities in Canada (Hay 1923, Gilmore, 1908) the sites of discoveries of *Mastodon americanus* occur south of a line roughly following the forty-fourth parallel of latitude. In Michigan the localities are south of a line from Ludington, Mason County, to Standish, Arenac County. In New York all

but one lie south of the location of the Rochester-Syracuse glacial-lake outlet. This distribution is so sharply marked that it has tempted me into much speculation regarding its cause.

The following modern forms of animal and plant life have been found associated with mastodon remains in Michigan: deer, wapiti, and fresh-water mollusks, and white spruce, black spruce, and tamarack. The only extinct form known to be thus associated is *Castoroides*, a giant beaver, reported by Hay from the town of Adrian, Lenawee County.

No evidence from fossils that proves the presence of mastodons prior to the advance of the Wisconsin glacier has been reported in Michigan. Their bones have been found elsewhere in earlier beds, but may be missing in Michigan because deposits containing such remains were disturbed by the last ice sheet.

I have located, by means of Leverett and Taylor's glacial map of the Southern Peninsula of Michigan (1915), the various types of deposits over which mastodon finds have been made. They are as follows:

	Percentage
Glacial drainage-channel material	26
Terminal moraines, mostly in peat	22
Ground moraines, mostly in peat	17
Sandy lake deposits	13
Glacial lake-bottom clays	10
Sandy drift, not definitely morainic	6
Other types	6

With one or two possible exceptions (MacCurdy, 1920) the remains occur above material of Wisconsin age, mainly in the muck and fillings of lakes and ponds.<sup>1</sup> This indicates that enough time had elapsed between the retreat of the ice and the invasion by the mastodons for plentiful vegetation to become established over a terrain very much like the present one. The fossils found over glacial-lake bottom clays show that the mastodons persisted in Michigan at least until the Great Lakes reached approximately their modern shore lines.

The abundance of mastodons found in Southern Ontario may serve to prove their existence during later glacial-lake times. If we may assume that a broad river can act as an effective barrier to the migration of mastodons, then, according to Leverett and Taylor's

<sup>1</sup> Hay's name, "Wabash beds" (1912), is preoccupied.

glacial-lake interpretations, there were three significant times when these animals might have migrated into Ontario (1) during the Grassmere stage of Lake Lundy, when a mere shallow strait connected the Huron and the Erie divisions of the ancestral Great Lakes, (2) during the Kirkfield stage of Lake Algonquin, when discharge occurred at the Kirkfield outlet and the Port Huron outlet was dry, (3) during the early stage of the Nipissing Great Lakes, when discharge was through the Nipissing-Mattawa River previous to the final Port Huron outlet stage

From the evidence at hand I conclude that the American mastodon arrived in Michigan after the ice had retreated from most of the Lower Peninsula, but before it had retired from the continent. Estimates of the length of time since the Wisconsin glacier left Michigan vary from 20,000 to 50,000 years, with the smaller figure more probable (Leverett and others)

Michigan seems to offer little or no evidence upon which an approximation of the time of the extinction of mastodons might be established. The shallow depths at which they are buried in bogs still actively accumulating peat point to a surprisingly recent date. Any estimates based on the rate of peat deposition are inconclusive because the rate of accumulation varies greatly owing to droughts, fires, and changes in local drainage.

Rather numerous accounts of mastodon fossils occurring with human artifacts and of Indian myths relating to elephant-like animals are reported from areas outside Michigan, but will not be reviewed here. The opinion of many writers, including myself, is that mastodons have only recently become extinct in North America and that they may have lived into historic times.

## LOCATIONS OF FINDS OF MASTODON REMAINS

The abbreviations in parentheses after names of counties are those used on the map (Fig. 1). Numbers at beginnings of lines correspond with those employed on the map to indicate the sites of finds. Parentheses around such numbers signify that the sites are unknown.

### *Allegan County (Al)*

- 1 Gun River, possibly in T. 1 N., R. 11 W. One tooth
- 2 Door, four miles west, approximately in T. 4 N., R. 13 W. Teeth and jawbone.



- 3 Fennville, four miles southwest, approximately in Sec 11, T 2 N, R 16 W  
One tusk

*Barry County (Ba)*

- 1 Hastings, possibly in Sec 16, T 3 N, R 8 W One tusk
- 2 Carlton, possibly in T 4 N, R 8 W Teeth and bones

*Bay County (Bay)*

- 1 Frankenlust, in the SW $\frac{1}{4}$  Sec 1, T 13 N, R 4 E "Traces"
- 2 Auburn, in the SW $\frac{1}{4}$  Sec 3, T 14 N, R 3 E Tusk, tooth, and bones

*Berrien County (Be)*

- 1 Snow, in Sec 26, T 6 S, R 19 W One tooth
- 2 Baroda, approximately in Sec 23, T 6 S, R 19 W Tusk, teeth, and bones
- 3 Galien, approximately in Sec 1, T 8 S, R 19 W Tooth and some bones
- 4 In the bed of the Paw Paw River Exact location doubtful Teeth and bones of possibly two specimens
- 5 Eau Claire, in Sec 32, T 5 S, R 17 W Teeth and some bones
- 6 Bakertown marsh, near Buchanan, in Sec 3, T 8 S, R 17 W Evidence of six mastodons
- 7 Watervliet, three and one-half miles southeast, approximately in Sec 1, T 4 S, R 17 W One tusk
- 8 Watervliet, two miles southeast, approximately in the SW $\frac{1}{4}$  of T 3 S, R 17 W One tusk (may be the same as 7)
- 9 Three Oaks, two miles east, approximately in Sec 1, T 8 S, R 20 W One poorly preserved skull, with teeth
- 10 Baroda, in the NE $\frac{1}{4}$  SE $\frac{1}{4}$  Sec 17, T 6 S, R 19 W Four teeth

*Branch County (Br)*

- 1 Archer's Lake, approximately in Sec 5, T 7 S, R 5 W Bone fragments
- 2 Quincy, in a small marl lake, in T 6 S, R 5 W One tooth

*Eaton County (Ea)*

- 1 Bellevue, in Sec 28, T 1 N, R 6 W Tusk, teeth, and bones
- 2 Olivet, four miles northeast, in the NW $\frac{1}{4}$  Sec. 11, T 1 N, R 5 W Eight teeth and many bones
- 3 Narrow Lake, approximately in Sec 33, T 1 N, R 4 W Teeth and bones
- 4 Millett, three miles northwest, in the SW $\frac{1}{4}$  Sec. 21, T 4 N, R. 3 W About two thirds of a skeleton

*Genesee County (Ge)*

- 1 Fenton, approximately in Sec 36, T 5 N, R 7 E. "Remains."
- 2 Davison, in T 7 N, R 8 E One femur
- 3 Davison, in Sec 4, T 7 N, R 8 E. Tusk, teeth, and bones
- 4 Otisville, in Sec 30, T 9 N, R 8 E. Two teeth

*Gladwin County (Gl)*

- 1 Beavertown, possibly in T 17 N, R. 1 or 2 W. Owner would not disclose exact locality Tooth and bones.

*Gratiot County (Gr)*

- 1 Alma, in the S $\frac{1}{2}$  NW $\frac{1}{4}$  Sec 22, T 12 N, R 4 W Teeth and bones
- 2 Alma, in the NE $\frac{1}{4}$  NE $\frac{1}{4}$  Sec 3, T 11 N, R 3 W Parts of three specimens
- 3 Riverdale, approximately in Sec 31, T 12 N, R 4 W Large number of bones and teeth
- 4 Ithaca, four miles north, in the SW $\frac{1}{4}$  Sec 17, T 11 N, R 2 W Skull and other bones

*Hillsdale County (Hi)*

- 1 Church, approximately in Sec 21, T 6 S, R 1 W Most of a skeleton

*Huron County (Hu)*

- 1 On an island in Saginaw Bay, near Sebewaing Location indefinite Pieces of bone

*Isabella County (Is)*

- 1 Fremont, four miles southwest, in the SW $\frac{1}{4}$  SW $\frac{1}{4}$  Sec 24, T 13 N, R 5 W One tooth

*Jackson County (Ja)*

- 1 Jackson(?), possibly T 2 or 3 S, R 1 W Owner would not disclose exact locality One tooth
- 2 Jackson, about one thousand feet east of center of Sec 9, T 3 S, R 1 W Left ulna and radius
- 3 Root State Prison Farm, in Sec 8, T 2 S, R 1 E Tusk, teeth, and bones
- 4 Portage Creek, approximately in the N $\frac{1}{4}$  of T 2 S, R 1 W Several bones

*Kalamazoo County (Ka)*

- 1 Valley flat of Kalamazoo River, in T 2 S, R 11 W One bone
- 2 Kalamazoo, in Sec 3, T 2 S, R 11 W Tusk, teeth, and many bones

*Kent County (Ke)*

- 1 Cannonsburg, approximately in Sec 23, T 8 N, R 10 W Lower left molar
- 2 Ross, in Sec 34, T 5 N, R 12 W Parts of three tusks and one tooth

*Lapeer County (La)*

- 1 Clifford(?), possibly in T 10 N, R 11 E Owner would not disclose locality Tooth.
- 2 Hadley, a village in Sec 21, T 6 N, R 9 E Tooth
- 3 Big Fish Lake, in Sec 33, T 6 N, R 9 E Tooth

*Lenawee County (Le)*

- 1 Tecumseh, in Sec 33, T 5 S, R 4 E Part of tusk, tooth, and bone fragments
- 2 Adrian, in Sec 2, T 7 S, R 3 E Lower jaw
- 3 Clinton, in Sec 7, T 5 S, R 4 E Foot bones.
- 4 Clayton, middle of the line between the SE and the NE $\frac{1}{4}$  SE $\frac{1}{4}$  Sec 7, T 7 S, R 2 E Lower jaw
- 5 Weston, two and one-half miles south, in Sec 32, T 8 S, R 3 E Three vertebrae and parts of leg bones.

- 6 Adrian, seven miles northeast, in Sec 7, T 6 S, R 3 E Tusks, teeth, and many bones
- 7 Seneca, two and one-half miles northeast, approximately in Sec 9, T 8 S, R. 2 E Tusks and bones

*Livingston County (Li)*

- 1 Exact locality not known T 4 N, R 6 E A femur
- 2 Tyrone, between Secs 27 and 28, T 4 N, R 6 E Tooth
- 3 Shiawassee River, in T 3 N, R 4 E Tooth and pelvis
- 4 Green Oak, approximately in Sec 11, T 1 N, R 6 E Molar
- 5 Howell, two miles southwest, approximately in Sec 3, T 2 N, R 4 E Tooth

*Macomb County (Ma)*

- 1 Clinton River valley flat, in the E $\frac{1}{2}$  NE $\frac{1}{4}$  Sec 31, T 3 N, R 12 E Teeth and jawbone
- 2 Mt Clemens, four miles south, approximately in Sec 33, T 2 N, R 13 E Teeth and many bones
- (3) Exact locality not known Molar and bones

*Midland County (Mi)*

- 1 Midland, in T 14 N, R. 2 E Exact location not given Tooth

*Monroe County (Mo)*

- 1 Petersburg, approximately in Sec 3, T 7 S, R 6 E "Remains"
- 2 Oakville, in Sec 3, T 5 S, R 7 E Tusk, teeth, and bones

*Montcalm County (Mon)*

- 1 Stanton, in the NE corner of T 10 N, R 7 W Teeth

*Muskegon County (Mu)*

- 1 Moorlands, two miles north, in the NE $\frac{1}{4}$  NE $\frac{1}{4}$  Sec 16, T 10 N, R 14 W Larger part of skeleton
- 2 Exact locality not known T 9 N, R 16 E Tusk, teeth, and bones

*Newago County (Ne)*

- 1 White Cloud, in northern part of T 13 N, R 12 E "Tooth or jawbone"

*Oakland County (Oa)*

- 1 Birmingham, three miles northeast, approximately in Sec 32, T 2 N, R 11 E Tusk, teeth, and bones.

*Osceola County (Os)*

- 1 Hersey, in the NE $\frac{1}{4}$  Sec 24, T 17 N, R. 10 W Tooth

*Ottawa County (Ot)*

- 1 Allendale, approximately in the SW corner of Sec 21, T 7 N., R 14 W Many bones.
- 2 Conklin, two and one-half miles northwest, in the S $\frac{1}{2}$  NW $\frac{1}{4}$  Sec. 19, T 9 N, R 13 W About a hundred bones

*Saginaw County (Sa)*

- 1 Saginaw, ten miles northwest, 0 25 mile N of S line of Sec 20, T 13 N, R 3 E  
Tusk fragment
- 2 Exact locality not known T 9 N, R 1 E Tooth
- 3 Bridgeport, three miles south, approximately in Sec 23, T 11 N, R 5 E  
Two teeth
- 4 Chesaning, approximately in Sec 9, T 9 N, R 3 E Teeth and ribs
- 5 Birch Run, four miles northeast, approximately in Sec 24, T 10 N, R 6 E  
Teeth and ribs
- 6 Elsie, eight miles east of north, in the SE $\frac{1}{4}$  SW $\frac{1}{4}$  Sec 4, T 9 N., R 1 E Three  
teeth

*St Clair County (SC)*

- 1 St Clair, five miles north, in Sec 2, T 5 N, R 16 E Two teeth
- (2) Exact locality not known On shore of Lake Huron Tooth
- (3) Port Huron, on the shore of Lake Huron Tooth fragment

*St Joseph County (SJ)*

- 1 Colon, three miles southeast, in Sec 24, T 6 S, R 9 E Teeth and bones
- 2 Prairie Lake, in the E $\frac{1}{4}$  of T 7 S, R 10 W Two bones

*Sanilac County (San)*

- 1 Marlette, in Sec 5, T 10 N, R 12 E Bone fragments
- 2 Kingston, six miles northeast, in T 12 N, close to the line of R 11 and R 12 E  
Tusk
- (3) Exact locality not disclosed by informant Tooth and bones

*Shiawassee County (Sh)*

- 1 Bancroft, near the line between Sec 36 and Sec 25, T 6 N, R 3 E Tusk,  
teeth, and bones
- 2 Venice, near the center of Sec 1, T 7 N, R 4 E Tooth and part of tusk
- 3 Owosso, approximately in Sec 24, T 7 N, R 2 E. Tooth

*Tuscola County (Tu)*

- 1 Cass City, four miles south, approximately in Sec 21, T 13 N, R 11 E  
Teeth and bones
- 2 Cass City, in southern part of T 14 N, R 11 E Numengus bones
- 3 Gilford, in Sec. 26, T 13 N, R 7 E Tusk, teeth, and bones

*Van Buren County (VB)*

1. Paw Paw River valley flat, approximately in Sec 26, T 3 S, R 14 W Lower  
jaw and teeth.
2. Lawton, approximately in Sec 31, T 3 S, R 13 W Tooth
3. Hartford, a few miles northwest, approximately in Sec 6, T 2 S, R 16 W  
Teeth and bones
- (4) Exact locality not known Tusk, teeth, and bones.
- (5) "Near Paw Paw Lake." Tooth

*Washtenaw County (Wa)*

- 1 Saline, approximately in Sec 36, T 3 S, R 5 E "Some mastodon remains"
- 2 Saline, two or three miles south, approximately in Sec 12, T 4 S, R 5 E Tooth.
- 3 Lodi, in Sec 23, T 3 S, R 5 E Tusk, teeth, and many bones
- 4 Ypsilanti, seven miles southeast, approximately in Sec 1, T 4 S, R 7 E Tusk, teeth, and bones
- 5 Saline, about six miles west, approximately in Sec 19, T 4 S, R 5 E Teeth and part of skull
- 6 Saline, about five miles southwest, approximately in Sec 17, T 4 S, R 5 E Tooth
- 7 Rogers Corners, in Sec 9, T 3 S, R 4 E Tooth
- 8 Macon, about three miles northeast, on the county line in the SW $\frac{1}{4}$  SE $\frac{1}{4}$  Sec 33, T 4 S, R 5 E "Remains"

*Wayne County (Way)*

- 1 Exact locality not given T 1 S, R 8 E Tusk and teeth
- 2 Trenton, in the NW $\frac{1}{4}$  NE $\frac{1}{4}$  Sec 12, T 4 S, R 10 E Tusk and many bones
- 3 Exact locality not known, possibly in T 3 S, R 11 E Vertebra

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# THE NINETY-YEAR PRECIPITATION CYCLE

EDWIN L MOSELEY

## RAINFALL

**I**T IS possible to predict excessive or deficient rain for years in advance with considerable probability of the prediction coming true. Much of the interior of North America receives its moisture principally from the Gulf of Mexico. Throughout a large part of this territory there is a tendency for the rainfall in any particular region to be much like that of ninety years before. In the Ohio River valley, for example, there were excessive rains nearly every year in the period 1846-52, likewise ninety years earlier, 1756-62, and ninety years before that, 1666-72. Now, in 1939, ninety years later, this region is again getting heavy rains.

New York State has early weather records for many stations. After selecting periods of a few months' duration in which a majority of these stations showed excessive or deficient precipitation I wrote out twenty-seven "predictions" of the probable rainfall ninety years and four or five months later and then compared them with recent records. Sixteen of them agreed, four conflicted, and seven of the twenty-seven periods had precipitation which was about normal although I had predicted otherwise.

In the early years of most states records were kept at only a few places or not at all. Yet the records of a single station afford some criteria by which to judge the probable rainfall ninety years later. In Pennsylvania those at Lebanon go back as far as the years following 1828. From these early data I postulated that there would be less than normal precipitation in the five months from November, 1922, to March, 1923. The late records showed that in every one of these months rainfall was less than normal. For October, November, and December, 1930, I predicted precipitation below normal. The records showed it to be below, the deficit being very marked in October and November. From February to May, 1924, I expected more than average rain. March had less than usual, but in the

period as a whole there was abundant rain. Of nine predictions which I made for Lebanon only two were poor, I had anticipated more rain than usual in April and May, 1921, but there occurred a deficit of nearly one third of an inch for the two months. I looked for less than the usual amount in June, July, and August, 1924; less fell in July and August, but June had heavy rain.

Ten predictions were made for Pittsburgh, Pennsylvania. Eight turned out well, the others were based on too small departures from normal in the period 90½ years earlier. Similar results were obtained in predicting for Kentucky and Ohio, where there are five stations with records more than 90 years old. Farther west there are very few records equally early, but on the basis of these I made fairly successful predictions for Wisconsin, Iowa, Missouri, and Louisiana.

#### TREE RINGS

Before attempting to correlate recent weather records with those ninety years earlier I deemed it important to find out, as nearly as possible, the actual length of the cycle. Each year a living tree forms a new layer of wood just beneath the bark. This annual ring, as it is called, shows by its thickness whether the tree was getting more or less than the usual amount of moisture at the time it was formed. A study of rings after a tree is cut down enables one to learn about the rainfall during its life. From the tops of stumps, the ends of logs, and cross sections taken from them I have made measurements representing more than four hundred large trees which grew in the region from southern Michigan to central Tennessee. A majority of them were between 180 and 370 years old, a few were still older, and so afforded information about the rainfall each year for the last four centuries.

In my earlier measurements I laid off zones in each of which were 46 rings, showing the growth of 46 years. In the summer of 1937 I concluded that I should use a 45-year period. In both periods, that is, the 45 and 46 years ending with 1890, I found that the trees grew more than in the following or the preceding period. Moreover, each even-numbered period proved to be a wet one, and with one exception each odd-numbered period a dry one. The study of individual rings, which was started later, has as yet been applied to only 120 trees, of which 81 were growing in the latter part of the eighteenth century, 46 in the seventeenth, and 12 in the sixteenth.

THE RECORDS

Dates of nearly all the years which show substantial agreement in their departure from the normal are given in Table I. Weather records go back a little more than a century, very few for the region west of New York State antedate 1835. They show that there was more than average rain when the trees made wide rings, and less than average when they made narrow ones. This correlation applies to the growing season, but not in all cases to the entire year.

As may be seen from the table, after an interval of 90 or 91 years each wet year was followed by another wet one, likewise each dry

TABLE I

YEARS IN WHICH A MAJORITY OF THE TREES IN THE REGION EXTENDING FROM SOUTHERN MICHIGAN TO TENNESSEE FORMED WIDE OR NARROW RINGS

<i>Wide rings</i>				<i>Narrow rings</i>			
	1852	1761	1671	1936	1845	1755	1665
	1850	1760	1669	1934	1843	1753	1663
1939	1849	1759	1668	1932}	1841	1751	1660
1938	1848	1758		1931}			
1937	1847	{1757 1756}		1930	1839	{1749 1748}	1658
1928	1837	1747	1657	1925	1834	{1744 1743}	1653 1652
1927	1836			1911	1821	1730	1640
1922	1832	1741		1910	1820	1729	1639
	1887	1797	1707	1907	1816	1726	1636
	1886	1796	1706	1904	1813	1723	1632
	1885	1795	1705	1901	1811	1721	1630
	1884	1794	1704	1900	1810	1720	1629
	1883	1793	1703	1899	1809}	1718	1628
	1881	1791		1898	1808}		
	1878	1788	1697(?)	1895	1804	1714	1624
	1877	1787	1696	1894	{1803 1802}	1713 1712	1623 1622
	1876	1786	{1695 1694}	1891	1801	1711	1620
	1869	1779(?)	1688	1890	{1800 1799}	*1710 1709	1619 1618
	1869	1769	1678	1874	1784	1693	1603
1868	1768	1677		1871	1781	1691	1600
				1870	1780	1690	1599
				1868	1778	1687	1597
				1867	1777	1686	1596(?)
				1864	1774	1683	1592
				1857	1767	1676	1585
				1856	1766	1675	1584



year by a dry one. If the precipitation cycle were as long as 90½ years, the 91-year interval would appear as often as the 90-year interval, but it does not. If the cycle were just 90½ years, then after three such intervals the difference would be 271 years, as it usually is, but sometimes it is 272 years, which implies that the cycle is a little more than 90½ years.

I made many attempts to correlate months of excessive or deficient rain, as shown by early weather records, with months between 90 and 91 years later. The best correlations were found after 90 years and five months, the next best after 90 years and four months. This result is in good agreement with the table of dates of wet and dry years indicated by the width of tree rings. Both methods lead to the conclusion that the length of the cycle is not far from 90½ years.

#### AREAS AFFECTED

The period of 90½ years used in making predictions for those parts of North America where rain is derived mainly from the Gulf of Mexico is four times the magnetic or double sunspot period, 22½ years. It does not apply to eastern Massachusetts or to other parts of New England near the ocean. For them I made successful predictions for the years 1931-37 by using a period of 67 years and ten months, which is three times the sunspot period. Predictions based on 1867, a year of minimum sunspots, were not successful.

For New York City, Long Island, and the Hudson and Mohawk valleys predictions made on either basis were failures, presumably because part of their rain comes from the Gulf, part from the Atlantic Ocean. The same thing is true for Fortress Monroe, Virginia, and Charleston, South Carolina. Baltimore and Washington gave fair results with the period of 90½ years.

#### LAKE LEVELS

The ninety-year cycle shows also in fluctuations of level of the the water in lakes and rivers. A few early records relating to Lake Ontario and some of the other Great Lakes are now more than ninety years old. Recent records show that ninety years after these lakes were unusually high they were again unusually high. For Lake Erie we have data that are much older than the written records. On Cedar Point, Erie County, Ohio, may be seen a series of long parallel sand and gravel ridges which were piled up by the waves when there

were great northeast storms. Only those storms which occurred at times of abnormally high water were able to build ridges that endured, the ridges that were formed at other times were not so far back on the land and, consequently, were destroyed by later storms.

A study made early in this century enabled me to assign to each of these old ridges the approximate date of its formation. These dates, as well as the methods employed in determining them, can be found in my monograph "Formation of Sandusky Bay and Cedar Point," *Thirteenth Annual Report of the Ohio Academy of Science*, 1904, pages 223-236. Several intervals of ninety years and multiples of ninety occur between the dates of formation of these ridges, the earliest of which was made about 1429 and the latest about 1879. This leads to the conclusion that the ninety-year cycle has affected the region of the Great Lakes during the last five centuries.

#### FLOODS

Most of the settlements which were made west of the Allegheny Mountains before the beginning of the nineteenth century were located near the Ohio River or its tributaries. We have records of a few great floods of this river between 1762 and 1832, each of them was followed by a great flood about ninety or ninety-one years later, the water in some of them attaining about the same height as in the corresponding early floods. Fortunately for our study the precipitation at six places along the river was measured and recorded long before the United States Weather Bureau was established. These records show that rainfall was excessive about ninety years and five months prior to every great flood from 1913 to the present.<sup>1</sup>

#### FORECAST

There follows a brief forecast of what may be expected regarding precipitation for nearly forty years to come. It applies to the populous area that extends from Missouri and Iowa to Pennsylvania and New York State; this is an area for which we have more early data regarding rainfall than we have for the states situated farther west or north or south. Much of the forecast will also apply beyond these limits — to southern Minnesota, eastern Kansas, parts

<sup>1</sup> Moseley, E. L., "Long Time Forecasts of Ohio River Floods," *Ohio Journal of Science*, 39: 220-231 1939.

of the Gulf States, and parts of Virginia and New England that are not near the coast

As in the past, we may expect wet and dry seasons. The dry ones will be less numerous than they were in the forty-five-year period from 1891 to 1935. Average precipitation will be greater than it was then, and much greater than it was during the twenty years beginning with 1917.

After the middle of 1943 the precipitation for nearly five years may not average above normal; in fact, a drought may be expected in many states from the latter part of 1946 until late in 1947.

In 1948 and 1949 much more rain than usual will fall, after that about the normal amount may be expected most of the time until 1957, except for a dry period in the latter part of 1954.

Late in 1957 and throughout most of 1958 a drought will affect a large area. Abundant rain will fall again in 1959 and the first part of 1960.

In several states farther west than New York and Pennsylvania the rainfall will average below normal during a period of more than four years beginning in the fall of 1960, especially in the first half of this period.

After 1964 precipitation will exceed the normal nearly every year for more than a decade.

BOWLING GREEN STATE UNIVERSITY  
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# **ANTHROPOLOGY**



## TIBETAN TEMPLE BANNERS

B A DEVERE BAILEY

**T**HE Tibetan ethnologic material secured by Dr Walter Koelz in 1932-33 for the University of Michigan Museums includes a group of forty-eight Lamaist temple banners or paintings ascribed by Dr Koelz to various monasteries, which, with one or two exceptions, are all located in the Ladakh division of the state of Kashmir, India. This territory is adjacent to High or Little Tibet, and both the Ladakh and the Balti districts of West Nari were formerly under Tibetan suzerainty. Lamaist influence, therefore, is strongly discernible in the culture of the Ladakh areas, although Kashmir as a whole is predominantly Muhammadan.

Lamaism, a term applied by Occidentals to the state religion of Tibet, is not, as is commonly supposed, merely a mixture of native demonolatry and an emasculated form of Buddhism peculiar to Tibet. Local deities were included in the Lamaist pantheon, and the ritual differs in many respects from the more conventional Buddhist type, but its pivot is essentially that form of the Mahāyāna doctrine that prevailed in India when Buddhist dogmas were first carried into Tibet, in the seventh century A D. The Tibetan pantheon is very extensive, and plastic images are important adjuncts in native ritual. The Lamaist temple painting is iconographic, its subject is usually anthropomorphic, and in terms of function the banner can be nearly equated with the religious image in the round. It is definitely regarded by Lamaists as sacred, but its degree of sanctity seems to vary with the individual worshiper. Regarded by some devotees merely as a reminder of the divine, to more devout sectarians it may represent a visible expression of deity, a pictorial "god-house" in which, as temporary residence, the divinity is actually manifested. The paintings are chiefly used as altar or wall hangings in temples located within the compounds of most lamaseries in Tibet. They are also found in the homes of many of the laity as accessories of family shrines and figure prominently in ceremonial processions.

The temple banner varies from miniature forms to ones measuring approximately  $3 \times 5$  feet, a favorite size seems to be about  $20 \times 27$  inches. The material used for the painting proper is generally buckram, but this varies greatly in the fineness of the thread and the closeness of the weave. Silk examples are rare,<sup>1</sup> and the choice of linen or, more often, cotton is probably based on the legend that the first image of the historical Buddha was projected upon a linen cloth. The painting surface is sized with glue and chalk or with a paste of lime, flour, and thin glue. It is then rubbed smooth and polished with a stone or a piece of conch. The dry pigments are usually imported from either China or India — whichever is nearer the banner's geographical source — and are mixed with thin hot glue. The painted surface is left unvarnished. As has been indicated above, the banner generally is rectangular and is suitably mounted to hang on a wall or to suspend from a staff when carried in processions. It is most often enclosed in a decorative textile border and when not in use may be rolled around a wooden cylinder affixed to the lower margin.

It seems fairly evident that during the centuries in which banners have been painted in Tibet an indigenous style has resulted from a fusion of imported elements that reflect other cultures. This synthesis, which may be conveniently termed the "Tibetan style," is plainly recognizable in many current examples of the paintings, and the contrast between such specimens and those showing well-defined alien influences is likewise readily apparent. Most of the banners in the present collection are Tibetan in style; a good number are Indian; and fewer are Chinese. Hasty consideration of this fact might attribute it to cultural contact dependent upon the geographical location of the general region from which the paintings come. But close analysis of the group indicates that the actual sources of the banners do not reflect their ethnological derivations, for in most

<sup>1</sup> Tibetan paintings are often described and, therefore, usually thought of as painted on silk. The writer has examined many hundred examples, only a very small percentage of which might be so classified. A careful analysis was made of all examples in the present group, which were definitely found to be of cotton fiber (*Gossypium* sp.), in several instances the filaments showed dwarf or immature growth and varied greatly in fineness. For this analysis indebtedness is gratefully acknowledged to the Division of Ethnobotany, Museum of Anthropology, in this University. Since cotton is not a commercial product in Tibet, China and India provide the usual sources; in the case of these banners the material probably originated from Indian looms.

instances where more than one specimen was secured from a single monastery or lamasery the banners show diverse ethnic influences<sup>2</sup>

In spite of the generally accepted idea that Tibetan temple paintings coming from a specific lamasery are produced by artists belonging to the local order, it appears obvious that our collection cannot be so considered. The lack of generic relation as well as disparities in cultural style can probably be explained, however, by the fact that, though the banners are theoretically executed by lamaserial painters — a fixed geographical index of origin being thus provided — many of them are really produced by itinerant artists, both Nepalese and Tibetan, who paint wherever opportunity offers. When these extramural craftsmen are commissioned, intrusive cultural elements, alien to the locality which is the actual source of the painting, are introduced into the design, in addition, since any group of banners may be the work of several different artists, heterogeneous aspects logically result. The condition is emphasized when paintings are donated by the laity, because such gifts are almost invariably executed by wandering Lama artists.

Even so, the total number of unrelated banners in this collection coming from six separate lamaseries within a comparatively small

<sup>2</sup> A tentative classification of the banners from the various monasteries is given in the following table

Monastery or monasterial location	Number of banners	Stylistic influence		
		Tibetan	Indian	Chinese
Spiti, Pin Valley (Kangra)	3	1	1	1
Labrang, Ladakh (Kashmir)	4	2	2	
Ladakh (indefinite) (Kashmir)	1		1	
Chango, Ladakh (Kashmir)	1	1		
Nago, Ladakh (Kashmir)	2		2	
Himis, Ladakh (Kashmir)	1	1		
Tetha, Ladakh (Kashmir)	1	1		
Titkse, Ladakh (Kashmir)	4	4		
Likir, Ladakh (Kashmir)	17	7	5	5
Kasha, Ladakh (Kashmir)	6	5	1	
Karsa, Ladakh (Kashmir)	4	3	1	
Lamayuru, Ladakh (Kashmir)	2	1	1	
Marsho, Ladakh (Kashmir)	1	1		
Not defined	1	1		
Totals	48	28	14	6



area seems disproportionately high. The cause of the disproportion probably lies, however, in the general reluctance at all times of supervising abbots to part with paintings except under compulsion of political upheaval or financial stress. When persuasion is occasionally effective, the specimens sold are naturally those less highly valued — because produced by outside painters — and in this category many of the examples considered above doubtless belong.

The special bibliography of Tibetan temple paintings is very small, but contemporary Orientalists familiar with the Tibetan scene, such as Roerich (10, pp 17-19) and Grousset (3, pp 287 ff), usually agree that native painting reflects a thoroughly conventionalized technique, wherein the artist is not allowed to deviate from strict canonical formulas. The process is described as a kind of stenciling of the pattern and involves a "transfer" of the design to the painting surface. Such stylization of either design or technique is not generally confirmed by the present collection. There are numerous examples that show marked freedom in design and personalized drawing, with no evidence of a cliché style or a stenciled pattern. It is known that freehand painting is practiced by Tibetan artists, and a number of the banners in this group give satisfactory proof of such handling.

Lack of technical restraint shown by freehand drawing may or may not be accompanied by a definite disregard of formula or actual carelessness in depicting the concept. With either of these latter factors present, interpretation of the banner's iconographic features is made more difficult. In theory, each of the major divinities of the Lamaist pantheon must be portrayed in a prescribed posture and a particular color, which often vary for different manifestations of the same deity, certain fixed positions for the hands are significant, each must be dressed according to an established style and, usually, must hold, or be adorned by, one or more symbolic objects. In practice, many deviations from these set rules occur, and they are particularly confusing because of inherent similarities in the identities and attributes of the various gods. Such representations necessitate the minute study of virtually every detail in the entire composition and measured consideration of these in relation to the whole. From this synthesis of essential and minor elements, if accurately evolved, emerges correct identification of the concept.

Stylistic variations in banners and the diverse ethnic influences represented by departures from a recognizable norm of style, whether

Tibetan, Indian, or Chinese, may be better understood by referring to Plates I, II, and III. The three paintings illustrated are all ascribed to the same lamasery, viz, Spiti, Pin Valley. That in Plate I is, in terms of style, obviously of Indian derivation. The central figure represents Maitreya, the "Compassionate One," or Fifth Human Buddha, surrounded by repetitive forms of self. Both the iconography and the decorative details of the throne on which the figure is seated are plainly in the Indian mood. The various animals and human effigies flanking the structure represent a specific Indian style. The drawing is mannered, precise, there is a tendency toward angularity, and the concept as a whole suggests geometrical treatment. Plate II, on the other hand, depicting Gautama Śākyamuni, the historical Buddha, shows decided Chinese influence. The composition, in spite of extensive decorative detail, is essentially simple. The anatomical features emphasize flowing lines and suave contours. The costume is handled in characteristic Chinese fashion, and Chinese peaches symbolizing immortality figure prominently in the upper ground. Plate III, representing Vajrasattva as a Bodhisat, may readily be classed as Tibetan in style, although the drawing lacks the fixed native mood evidenced by more typical examples and suggests contemporary, rather than inherited, dilution by foreign elements — in this case probably Indian. The composition, also, shows a markedly decorative quality, which contrasts with the more realistic approach of Tibetan drawing. The iconographic features, however, are developed in terms of Tibetan concepts, and as a whole the initial estimate seems correct.

Plate IV illustrates Pal-ldan Lha-mo, the "Glorious Goddess." This painting is, from a technical standpoint, the finest of the entire group and would probably rank with the best examples in Occidental collections. The composition, drawing, and method of developing detail all reflect the Tibetan style, and though the meticulous treatment of the design possibly indicates Nepalese traits the banner is an excellent specimen of the native mood, as here considered. It came from the lamasery of Likir, in Ladakh, to which source the banner shown in Plate V is likewise ascribed. This painting, the only non-anthropomorphic example in the group, depicts a very unusual iconographic design. Double triangles, the upper telescoped by the apex of the lower, are geometrical symbols of the male and female, static and kinetic aspects of the "Two-in-One" in the Śakta system.

The theme is Indian, but development and handling of the composition are essentially Tibetan. Plate VI shows a banner, again in the Tibetan style, coming from the monastery of Tetha, Sanakkar, in Ladakh. It represents Beg-ts'e, god of war, and is a good example of the direct approach and angular quality of design of this type. Both anatomical features and symbolic detail seem unquestionably in the Tibetan manner.

Because all painting in Tibet is anonymous the dating of temple banners such as those in the present group is highly speculative. Certain clues to age, of doubtful value, are furnished by styles shown in the drawing and by the handling of iconographic detail. When paintings come from areas adjacent to the Chinese border, or probably involve the use of pigments imported from China, some idea of period is had by comparing the colors used with like shades on Chinese artifacts that can be accurately dated. Occasionally a banner is inscribed, but these legends usually refer to the figures portrayed or to the donor of the painting. A self-portrait of the artist is sometimes found in an obscure corner of the design; since this is not identified, however, it is valueless as a clue to the period of production. The condition of the banner seems in most cases to bear little relation to its age and consequently gives no satisfactory evidence as to the latter. It is obvious that an old specimen which has not been carefully preserved will show signs of wear, but on the other hand many factors affect the painting surface and the banner as a whole, and a much worn and partly disintegrated specimen may be relatively new. The paintings are not varnished, consequently dampness, indirect exposure to the elements — since Tibetan lamasery windows are usually protected only by cloth — and especially the almost constant fumes of butter-lamps burned before the banners by devotees, all these can contribute a fictitious appearance of age. Again, paradoxically, a painting that otherwise shows evidence of some antiquity may have been carefully preserved and may, therefore, be in excellent condition. It is probable that most of the paintings in Occidental collections, if conservatively dated, would not be assigned to a period earlier than the eighteenth century A D, and many of those commonly available might be accurately referred to the last half of the nineteenth. This generalization can be applied to the banners under survey with one exception, a painting which may be tentatively dated within the seventeenth century.

The restoration of painted areas on banners in poor condition provides something of a problem. When sections, however small, are quite bare of paint or otherwise permanently damaged, any restoring is, of course, purely artificial and generally unwise, since the original condition of the painting is obviously changed. When the damaged parts merely show scratches and minor paint lesions, skilful filling in with similar tempera colors betters the appearance. Several examples in this collection that appeared faded have been considerably improved by the careful application of light drying oil to the painted surface. If the oil is gently rubbed along the fabric with a soft cloth, surface dirt is removed and obscured detail is brought out by the livening of the pigments. More thorough cleaning may usually be effected with safety by using a plastic form of boiled rice in similar fashion and by removing the surplus promptly to avoid penetration of the painted areas by excess moisture. This method is successfully followed by Tibetan lamas, but it is suggested that it be tried experimentally upon small sections of the painting, since the pigments used are not uniformly stable and the more fugitive colors might be adversely affected.

The technical excellence of the paintings in this group varies greatly, but their value from an ethnologic standpoint obviously consists in their importance as cultural expressions, and what is artistically a second- or even a third-rate banner may be a significant research specimen.

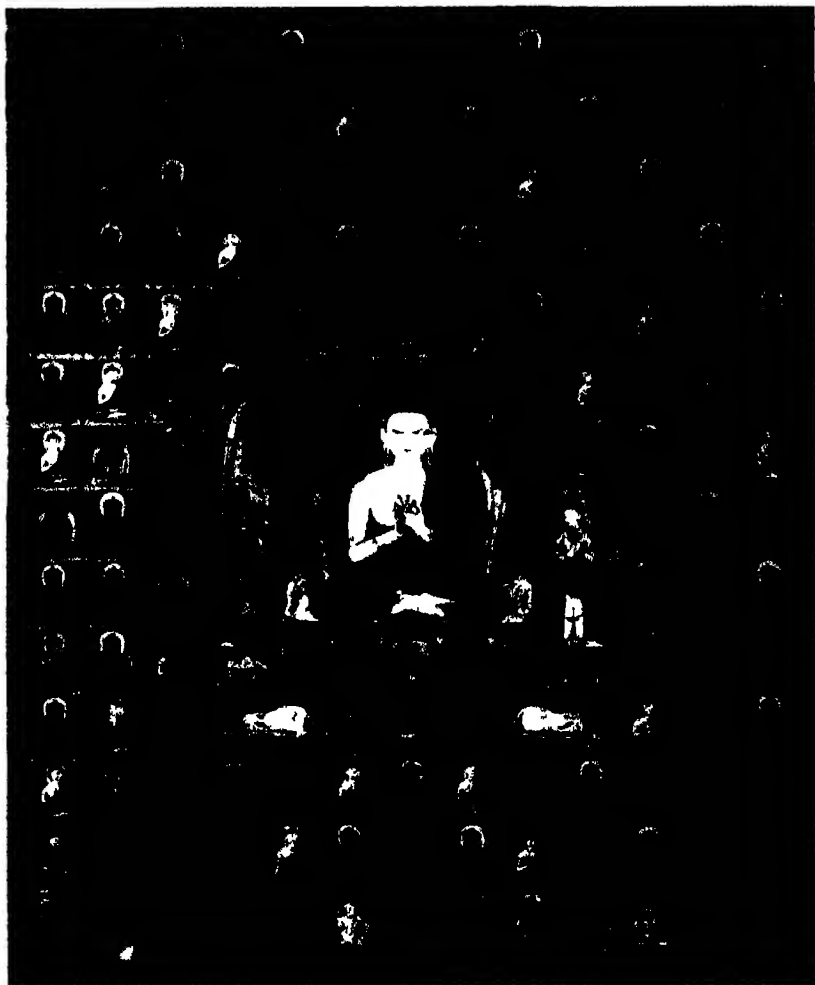
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Maitreya, as the future fifth human Buddha

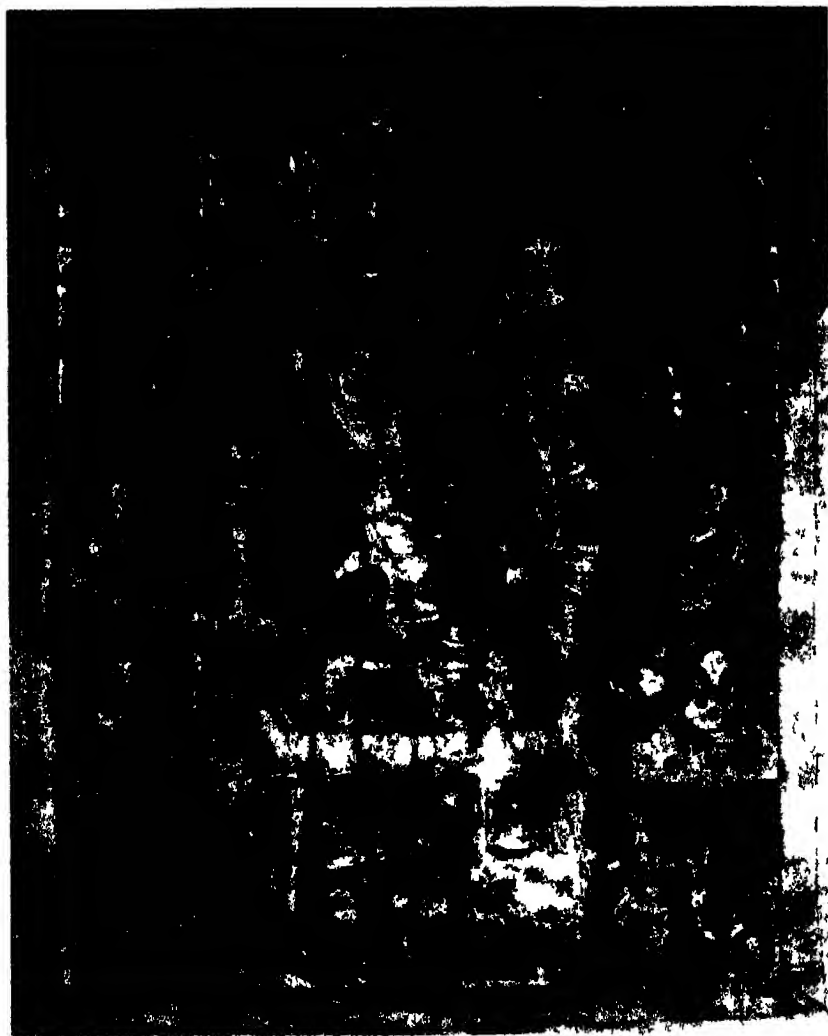




Gautama Śakyamuni, the historical Buddha







Vajrasattva, as a Bodhisat





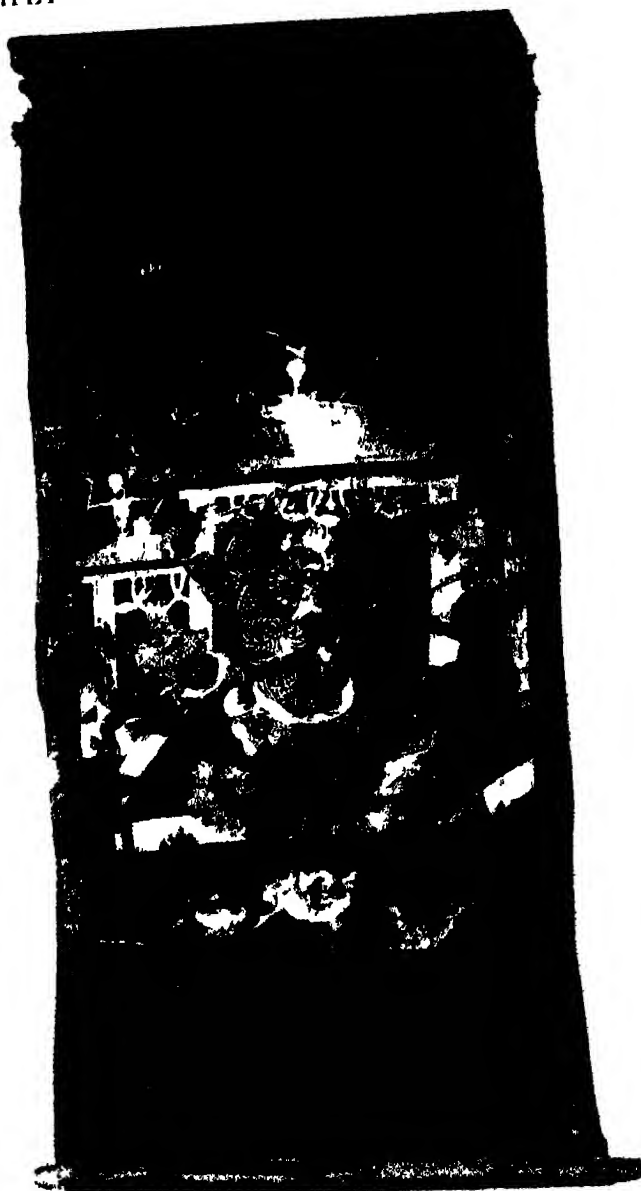
Pal-Idan Lha-mo, consort of Yama and one of the Dharmapāla





A Śakta symbol of static and kinetic forces





Beg-ts'e, god of war





## THE GROUNDNUT AS USED BY THE INDIANS OF EASTERN NORTH AMERICA

GRETCHEN BEARDSLEY

THE early explorers and colonists who came to the New World seeking adventure and fortune readily adopted the agricultural methods and crops of the Indians. They also learned the manner of gathering and utilizing various wild plants. One valuable wild food plant which was known to and used by the Indians throughout its range was the groundnut. It soon came to the attention of the colonists, and its importance to Indians and colonists alike is attested by the many references to it in early historical literature.

The groundnut (*Apios americana* Med.)<sup>1</sup> is a delicate twining vine of the bean family (Leguminosae). It was formerly common in damp or marshy soil throughout the woodlands and prairies of eastern and central temperate North America. The underground stems (root-stocks) have, at intervals, spherical or oblong tubers, which may reach the size of a hen's egg. This unusual feature, which was noted and mentioned by many of the early chroniclers, offers a means of identifying the plant from their descriptions. The starchy tubers were the part generally used, although it has been stated that the seeds also were sometimes eaten. Gilmore (9, Pl 17, facing p 94) published an illustration of the plant showing vines, tubers, and seeds.

References to groundnuts by early historians are found in accounts of explorations made along the Atlantic coast and in the East in general. In writing of the newly discovered land of Virginia Thomas Harriot, who accompanied Sir Walter Raleigh on his expedition in 1584, says (13, p 117): "Openauk are a kind of roots of round forme, some of the bigness of walnuts, some far greater, which are found in

<sup>1</sup> *Apios americana* Med. appears to be the accepted name at present. In some of the literature here cited it has also been referred to under the synonymous names *Glycine Apios* L., *Apios tuberosa* Moench., and *Apios Apios* MacM. It should not be confused with the peanut (*Arachis hypogaea*), which in Europe is sometimes called groundnut.

moist and marsh grounds growing many together one by another in ropes, or as though they were fastened with a string Being boiled or sodden they are very good meate " Although he does not say that the plant is the groundnut, the description and the Indian name leave no doubt of its identity

In a report to Raleigh, John Brereton, a member of Captain Gosnold's expedition to the shores of New England in 1602, describes the plant as follows (3, p 7) "Also, in every Island, and almost in every part of every Island, are great store of Groundnuts, fortie together on a string, some of them as bigge as hennes eggs, they grow not two inches under ground the which nuts we found to be as good as potatoes " He adds (p 13) that the tubers are "good meat" and also "medicinable "

In 1613 Beincourt and his followers located at Port Royal used the tubers for potatoes (26, p 274)

In the spring of 1623 the Pilgrims, "having but a small quantity of corn left," were "enforced to live on groundnuts and such other things that the country afforded and were easily gotten " (44, p 329)

Colonel James Smith, a captive among the Delawares from 1755 to 1759, says (19, p 33) " they gave us a kind of rough brown potatoes which grew spontaneously, and were called by the Coughnewagas ohnenata These potatoes peeled and dipped in racoon's fat taste nearly like our own sweet potatoes "

Peter Kalm, a Swedish botanist, traveling in eastern North America in 1749, speaks at greater length (18, p 96) "Hopniss or Hapniss was the Indian name of a wild plant, which they ate at that time The Swedes still call it that name, and it grows in meadows in good soil The roots resemble potatoes, and were boiled by the Indians who ate them instead of bread Some of the Swedes at that time likewise ate this root for want of bread Some of the English still eat them instead of potatoes Mr Bartram told me, that the Indians who live farther in the country do not only eat these roots, which are equal in goodness to potatoes, but likewise the pease which ly in the pods of this plant, and prepare them like common pease Dr Linnæus calls the plant *Glycine apios* "

Writing of his travels through Virginia (about 1612) Strachey makes this observation in regard to the Indians (38, p 73). "In June, July, and August they feed upon roots of tockohow, berries,

groundnuts, fish and greene wheate, and sometyme upon a green serpent, or green snake, of which our people likewise use to eat."

In a description of the Indian food plants of eastern Canada by Le Jeune, a French Jesuit missionary, we find the following comment (20, p 273) "They eat, besides, roots, such as bulbs of the red lily,

another that our French people call 'Rosary' because it is distinguished by tubers in the form of beads "

Several more recent authors state that *Apios americana* was an important food plant of the North American Indians.<sup>2</sup> They do not mention any specific groups, which indicates that the groundnut was generally used by all peoples living within its natural range.

Various references have been made to the use of groundnuts by Indian tribes. Those of the eastern groups who used it extensively were the Iroquois,<sup>3</sup> the Menomini,<sup>4</sup> the Potawatomi,<sup>5</sup> the Meskwaki,<sup>6</sup> the Delaware,<sup>7</sup> and the Chippewa.<sup>8</sup> It is interesting to note that neither Densmore (6) nor Smith (35) records its use by the Chippewa in Wisconsin. Rafinesque (as quoted by Havard, 15, p 101) states that in ancient times the Creeks cultivated the plant not only for the tubers but also for the seeds, and that they were still doing so when he visited them. Beverly (2, p 140) and Willoughby (42, p 85) note that groundnuts were used by the Indians of Virginia.

Brinton (4, p 50), writing of the Lenape in 1885, says "Of wild fruits and plants they consumed the esculent and nutritious tubers on the roots of the Wild Bean, *Apios tuberosa* which the Indians called hobbenis "

We learn from Parker (25, p 106) that the Iroquois employed groundnuts in considerable quantities until about thirty years ago. He states that "The groundnut was the favorite root of a captive tribe, according to tradition, and became the totem of a clan." He refers the reader to the *Paris Documents* of 1666 as the source of this information. In the *Documents* (24, p. 4) one notes that the sixth

<sup>2</sup> Carr (5, p 169), Havard (15, pp 101-102), Newberry (21, p 34), Palmer (22, p 405, 23, p 600), Pickering (27, pp 768-769), Rusby (29, p 458), Stout (37, p 53), and Unger (39, p 311).

<sup>3</sup> Harris (14, pp 107-109), Hedrick (16, p 31), Parker (25, p 106), and Waugh (40, p 120).

<sup>4</sup> Skinner (31, p 152) and Smith (33, pp 68-69).

<sup>5</sup> Smith (36, pp 103-104).

<sup>6</sup> Smith (34, pp 259-260) and Skinner (32, p 38).

<sup>7</sup> Brinton (4, p 50) and Kephart (19, p 33).

<sup>8</sup> Gilmore (9, pp 133-134).

tribe of the second division of the Iroquois "is that of the Potatoe, which they call Schoneschironon" In the same volume (p 10) there is a drawing of a string of "potatoes" resembling groundnuts, with this explanation "This is the manner they paint the tribe of the Potatoe" No reference is made to a captive tribe or a clan totem, unless one interprets "clan" and "tribe" to mean the same thing Harris (14, p 108), too, suggests that the groundnut was the totem of a captive tribe "whose special food consisted of potatoes, or whose particular business was the cultivation of that class of roots" Since the tuber was considered a food staple by most groups living within its range, a group might have selected it as their totem, but no basis for such an assumption is given

There is evidence that the groundnut was employed by some of the prairie tribes Gilmore (8, p 94) tells of its use by several of the Caddoan and Siouan tribes of the Missouri River region, and Prescott (28, p 453) and Palmer (22, p 405) preserve records of it among the Sioux The Cheyenne Indians of Montana described a food plant which Grinnell took to be the groundnut (12, p 179) Botanical manuals, however, do not give the range of this plant as extending so far west, and it seems likely that the plant they knew was one similar to the groundnut rather than the groundnut itself

When not eaten raw the tubers of the groundnut were prepared in various ways The Indians boiled them alone or with meat or corn, and roasted them in hot ashes They sometimes added maple sugar as a seasoning The Chippewa were especially fond of it as a seasoning for all their food The Menomini make a preserve by boiling the tubers in maple syrup The Potawatomi now living near Athens, Michigan, occasionally boil the tubers Mrs. Mary Mendoke, one of the oldest members of the village, told the writer that she had often eaten them in her youth. All the Potawatomi who live near Bradley, Michigan, know the plant well, but they no longer use it.<sup>9</sup>

The groups which harvested the tubers for winter use generally peeled them and dried them in the sun In drying them the Menomini usually built scaffolds of cedar bark and covered them with mats. They sometimes put the dried ones in maple syrup or sugar for

<sup>9</sup> Field data on the Potawatomi and the Chippewa were collected during the summer of 1938 under the auspices of the Museum of Anthropology of the University of Michigan

winter use The Meskwaki and the Chippewa peel, parboil, slice, and dry the tubers As a rule, they stored in woven sacks, boxes, or bark-lined pits those which they dried Gilmore (9, pp 133-134), Kalm (18, p 96), and Rafinesque (as quoted by Havard, 15, p 101) reported that some groups of Indians ate the seeds as well as the tubers There is no reason why they could not have done this, but the small seeds would not offer a very great source of food

An analysis of tubers fresh and dried shows high starch content in both and a high protein content in the dried material (43, p 657) The percentages are given in the following table

	<i>Moisture</i>	<i>Reducing sugar</i>	<i>Nonreducing sugar</i>	<i>Starch</i>	<i>Hemicellulose</i>
Fresh	82	16	127	149	241
Dried		17	138	143	263
	<i>Protein</i>	<i>Ash</i>	<i>Crude fiber</i>	<i>Ether</i>	
Fresh					
Dried	175	47			

A number of writers hold that the groundnut was cultivated by Indians As mentioned previously, Harris (14, p 108) states that a tribe of captives among the Iroquois had the particular business of cultivating it Havard (15, p 101) quotes Rafinesque as authority for the cultivation of the plant by Indians (tribes unspecified) in pre-Colonial times and by the Creeks at the time of Rafinesque Stout (37, p 53) and Hedrick (16, p 31) also mention the cultivation of the groundnut. What these four authors mean by "cultivated" is uncertain It would seem doubtful whether the groundnut was ever planted in rows in cleared fields or whether it ever constituted an important crop among any tribe However, so valuable a plant would certainly be protected and encouraged and perhaps, on occasion, transplanted to places near villages to make the supply more convenient Probably Waugh's statement (40, p 120) that the tubers are "sometimes planted in suitable locations, though they are not, strictly speaking, cultivated," about sums up the situation

In the literature referred to in this study many interpretations of Indian names of the groundnut appear It seems worth while to call attention to certain interesting aspects of them, but no critical linguistic investigation will be attempted Informants at the Walpole Island Reserve, Ontario, gave the Chippewa of the plant

as *pin* (plural, *pinak*) Gilmore (9, p 133) records the Chippewa name at Pinconning, Michigan,<sup>10</sup> as *pin*, but does not list the plural. The root *pin* seems to occur in many of the Chippewa terms for edible roots (9, pp 133-134), and we note this or similar syllables in most of the Algonkian terms for the groundnut.<sup>11</sup> The various Iroquoian terms cited by Waugh (40, p 120) and Harris (14, p 107) seem to reveal no basic similarity. The *hapniss* or *hopniss* of Kalm (18, p 96) shows no resemblance to any names recorded elsewhere. Prescott (28, p 453) and Palmer (22, p 405) gave the Siouan name as *mendo* and *modo*, respectively. These appear to be interpretations of *mdo*, as recorded for the Santee by Gilmore (8, p 94). Gilmore (*loc cit*) points out the interesting fact that the Teton Dakota term *blo* has been transferred to the potato since its introduction among them. Palmer (22, p 405) implies that the *pomme de terre* of the French was likewise first applied to the groundnut and later transferred to the potato.

Remains of food plants are frequently found by archaeologists in the course of their excavations of Indian sites. Since the groundnut was so important a food plant and was used over so wide an area, it would be expected to occur in the materials from such sites. Several tubers were dug up at the Hill Site, near Red Cloud, Nebraska (41, p 59, and Pl 2a). These were identified by Gilmore (41, pp 59-60) as tubers of *Apios tuberosa*. This site, however, is considered to be a historic Republican Pawnee village (41, p. 34), and the tubers, although old, are more recent than those mentioned in much of the early historical literature just cited. Gilmore (10) has identified tubers of the groundnut in material from four Ozark Bluff-Dweller sites.<sup>12</sup> In the present state of archaeological knowledge it is not possible to determine the age of these sites, but they are regarded as definitely pre-Columbian and may be somewhat older. It seems probable that future archaeological work will produce more such material and that further studies of chronology will make it possible

<sup>10</sup> Gilmore points out that the name of this town is derived from the Chippewa name of the locality, *pinkaning*, the etymology of which is "the place of the pin," in reference to the former abundance of the groundnut.

<sup>11</sup> See Smith for the Menomuni *ma tetaupa nuuk* (33, p 68), for the Forest Potawatomi *mukwo pinuk* (36, p 103), for the Meskwaki *mukwo peniak* (34, p 250), and Havard (15, pp 101-102) for the *openauk* of the early historical writers of Virginia and the *penace* of the "Canadian" Indians.

<sup>12</sup> This material was collected by Professor S. C. Dellinger, of the University of Arkansas, and is in the museum of that University.

to determine more definitely the antiquity of the use of the groundnut

Asa Gray, the eminent American botanist, made the interesting suggestion that the groundnut lost its opportunity through circumstances of history. He expressed the opinion (11, p 110) that, if civilization had begun in America instead of in Asia, the groundnut would have been the first developed esculent tuber and would have held its place in competition with potatoes and sweet potatoes, which might have been acquired later. This remark by an eminent authority and its repetition by such authors as Beal and Wheeler (1, p 515), Havard (15, p 102), Saunders (30, p 3), and Hinsdale (17, p 19) has probably received wide attention and credence. There is some doubt, however, that this optimistic opinion of the potentialities of the groundnut is justified. Havard (15, p 102) believes that cultivation by the Indians had no effect on the size or the quality of the tubers and asserts that experiments by Vilmorin and others to improve it were unsuccessful. He states, further, that it is of slow growth and laborious to gather. Stout (37, p 53) seems to share Havard's view, also claiming that experiments designed to improve the groundnut failed to increase the size or the number of the tubers. It would appear, therefore, that, although the groundnut served the Indians and the colonists well as a food plant, it was not destined for any greater rôle, it has now fallen into almost total disuse.

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## SOME NOTES ON USES OF PLANTS BY THE COMANCHE INDIANS

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THE notes on which this paper is based were gathered chiefly by Mr Carlson during the summer of 1933, while a fellow of the Laboratory of Anthropology of Santa Fé, New Mexico, and a member of a field group of that institution led by Dr Ralph Linton. The research was made on the Comanche Indian Reservation near Indianola, Comanche County, Oklahoma, as a small part of a general ethnographic study of the Comanche. The briefness of the expedition and the broadness of the general investigation did not permit much time to be spent on ethnobotany. It is realized that this paper does not by any means exhaust the subject of Comanche plant uses, and it was hoped that further field work might be done. As this has not been possible and as the publication of the bulk of the report of the expedition may be delayed, it seems advisable to publish these notes at this time.<sup>1</sup>

An educated Comanche informant-interpreter, Herman Asenap, assisted materially in contacting the older non-English-speaking members of the tribe and was of invaluable aid in acquiring and interpreting information. Whenever possible a specimen of the plant to be identified was gathered in the presence of the informant, but when this was not practical as complete a description as possible was obtained. Suggestions concerning the identity of a number of these plants have been made with some assurance from descriptions, common names, and manner of use. The specimens which were

<sup>1</sup> Thanks are here expressed to the Laboratory of Anthropology of Santa Fé, to Dr Linton, and to members of the party for permission to publish these data.

collected have been deposited in the Ethnobotanical Laboratory of the Museum of Anthropology, University of Michigan (catalog numbers 14398-14450)

Mr Carlson is responsible for the field notes, native terms, and phonetics. Dr Waldo R. Wedel cooperated with him in the collection of the field data. The identification of the plants, documentation, and comparative data are primarily by Mr Jones. Some assistance in identifications was received from Dr J. H. Ehlers and Mr Alfred F. Whiting.

Profitable investigations of aboriginal uses of plants are practically impossible among many Indian tribes because of their removal to reservations away from their native habitats or because of long contact with the white man and almost complete assimilation of his culture. This is not true of the Comanche, for although probably originally a northern Plains tribe they are now located in the same general region in which they were found by the first white explorers in the area (19, pp. 59-60), and, although they have been in fairly close contact with the white man for over a hundred years, their conversion to "civilization" has not been of such completeness or of such long standing that all their recollections of old times have been lost. The average Comanche has a very good knowledge of his plant environment and particularly of those plants which are or have been of value to his tribe.

This Comanche knowledge of useful plants and the fact that our list, although not extensive, could be compiled in a very short time would seem to argue against the prevalent opinion that the typical Plains tribes depended but little on them. While we are quite willing to concede that the Comanche were primarily hunters and that they relied largely on game for food, clothing, and the satisfaction of other wants, our data seem to indicate that this side of their life may have been overemphasized and their dependence on plants neglected. We feel that with additional field work the present list of Comanche economic flora could be readily amplified, and, further, that the ethnobotanical approach would be a profitable one among various other Plains tribes. Gilmore's monograph on the uses of plants by the Indians of the Missouri River region (7) demonstrates the great importance of plants in the lives of these sedentary agricultural tribes of the prairies.

Such data as exist concerning the ethnobotany of the tribes of

the plains people have been gathered chiefly as incidental parts of larger ethnographic studies, are generally meager, and are widely scattered. Two notable lists of plants used by Indians of the northern Plains are those of Grinnell for the Cheyenne (9) and McClintock for the Blackfoot (13). For the tribes of the southern Plains there is almost nothing available.<sup>2</sup> It is to assist in filling this hiatus in southern Plains ethnobotany that this paper is offered.

The data have been tabulated in order to present the material in compact form and to provide a convenient listing of plants by scientific name, common name, Comanche name, or by use (Table I). In the discussion the plants are arranged according to function, i.e. nutritive, medicinal, technological, and the like. Whenever convenient, identical or similar uses of the same or related plants by other tribes are pointed out. A small amount of data on Comanche uses of plants is drawn from other sources. We are grateful to Dr. E. Adamson Hoebel for permission to include some of his unpublished notes on plant names and plant uses of the Shoshone Indians, collected among the northern Shoshone of the Fort Hall Reservation, Idaho, in 1934.

The phonetic alphabet employed in recording the Comanche plant names is that of the International Phonetic Association. Since this alphabet is in common use and should be readily available to the reader it is not reproduced here.<sup>3</sup> We are further grateful to Dr. Hoebel for assistance in checking the phonetics of plant names.

Wissler (26, pp. 218-219) lists among the chief traits of the typical Plains tribes "the dependence upon the buffalo or bison, and the very limited use of roots and berries." Marcy and McClellan (15, p. 102) state that fresh meat was the only food of the Comanche "with the exception of a few wild plants which they find on the prairies." Our data seem to indicate that rather full use was made of the available flora. Many fruits and berries were eaten and must have offered a welcome variation to the monotony of the meat diet. Nuts, starchy roots, bulbs, and various other plant parts were also utilized. Some of these offered only fresh seasonal food, and others

<sup>2</sup> Since this paper was written a monograph by P. A. Vestal and R. E. Schultes has appeared in which over a hundred Kiowa economic plants are discussed (*The Economic Botany of the Kiowa Indians as It Relates to the History of the Tribe*, Botanical Museum, Cambridge, Mass., 1939, 110 p.).

<sup>3</sup> For a slightly modified form of this alphabet see Bloomfield (2, p. 547).

TABLE I  
PLANTS USED BY THE COMANCHE INDIANS

Scientific name	Catalog no	Common name	Comanche name	Comanche use
<i>Allium</i> spp	No specimens	Wild onions	pak <sup>h</sup> k, large onion t <sup>h</sup> diekt <sup>h</sup> k, small onion	Bulbs roasted and eaten
<i>Ambrosia ptilostachya</i> DC	14425	Western ragweed	wanatsu	No use known to informant
<i>Amorpha angustifolia</i> (Pursh) Boynton	14433	False indigo	saba <sup>h</sup> ia <sup>h</sup> si <sup>h</sup>	No use known to informant
<i>Andropogon scoparius</i> Michx.	14413	Little bluestem grass	eksniip	Stems used as switches in the sweat lodge, ashes from stems used for treating syphilitic sores
<i>Argemone intermedia</i> Sweet	14443	Prickly poppy	pitata <sup>h</sup> u	Sore eyes treated with sap
<i>Artemisia filifolia</i> Torr	14410	Silvery wormwood	paawonapoh <sup>h</sup> si <sup>h</sup>	As mattress in childbirth, as cushion in tipi
<i>Artemisia ludoviciana</i> Nutt	14415	Lobed cudweed, white sage	poh <sup>h</sup> si <sup>h</sup>	Known to be used but precise use not known
<i>Brayodendron texanum</i> (Scheele) Small	No specimens	Mexican persimmon	dunaseika	Fruits eaten
<i>Camassia esculenta</i> (Ker) Robinson?	No specimens	Wild hyacinth, camass	sukoi	Roots eaten raw
<i>Carya illinoensis</i> (Wang) K. Koch	14448	Pecan	nakut <sup>h</sup> ai	Nuts eaten, leaves used in treatment of ringworm

<i>Celtis laevigata</i> Willd.	14435	Southern hackberry	natsakwz, mitsaná	Fruits mixed with fat and eaten
<i>Cephalanthus occidentalis</i> L.	14417	Buttonbush	pesotai	Game sticks made from wood
<i>Cirsium undulatum</i> (Nutt.) Spreng	14412	Thistle	tsan	Roots eaten, infusion of roots used as medicine for gonorrhea
<i>Cornus asperifolia</i> Michx.	14430	Rough-leaved dogwood	parioŋi	Arrow shafts made from stems
<i>Coryphantha</i> sp.	14403	Cactus	Not recorded	Unfaithful wives punished with spines
<i>Crataegus</i> sp.	14421	Thornapple, locally called "red haw"	tidamawo.	Fruits eaten
<i>Crataegus</i> sp.	14416	Thornapple, locally called "black haw"	tópoka, fruit wokwe'kate, tree	Fruits eaten, inner bark chewed as gum
<i>Croton monanthogynus</i> Michx.	14446	Croton weed	guššamawa	Leaves mixed with animal brains for use in tanning
<i>Cymopterus aculeis</i> (Pursh) Rydberg?	No specimens	<i>Cymopterus</i>	tun'ha	Rootstocks eaten
<i>Diospyros virginiana</i> L.	14436	Persimmon	nase'ka	Fruits eaten fresh or dried
<i>Echinacea</i> sp.	14408	Purple coneflower	ŋakunamatsu	Roots used in treating sore throat and toothache
<i>Elymus</i> sp.?	14427	Rye grass	putaseeni	No use known to informant
<i>Eriogonum longifolium</i> Nutt.	14429	<i>Eriogonum</i>	ekanasu, ekana- áŋpa	Stomach trouble treated with infusion of roots



TABLE I (Continued)

Scientific name	Catalog no.	Common name	Comanche name	Comanche use
<i>Gutierrezia sarothrae</i> (Pursh) B & R.	14431	Snakeweed	sanawelha, oboya	Brooms made of stems, leaves used in treating whooping cough
<i>Helenium autumnale</i> L. ?	14422	Sneezeweed	tidikwrbam	Used in bath for treatment of fever
<i>Helenium macrocephalum</i> Gray	14411	Sneezeweed	nates'ksa	Used to induce sneezing in order to clear nasal passages or to expel afterbirth
<i>Hoffmannseggia Jameai</i> T & G	14419	<i>Camote de ralon</i>	pa tsamu	Tubers eaten
<i>Ilex</i> sp. ?	No spec- imen	Holly, yaupon	Not recorded	Beverage made from leaves
<i>Juglans nigra</i> L.	No spec- imen	Black walnut	mußitai	Nuts eaten, leaves used in treat- ment of ringworm
<i>Juniperus virginiana</i> L. .	14440	Juniper, red cedar	ekawaip'	Fruits eaten; smoke from leaves thought to have purifying effect
<i>Lespedeza capitata</i> Michx.	14441	Bush clover	pubihußi'	Beverage made from leaves
<i>Lesris punctata</i> Hook.	14449	Button snakeroot	ataßitsanoi	Roots chewed for juice, remedy for swollen testes
<i>Lophophora Williamsii</i> (Lem.) Coalter	No spec- imen	Peyote	Not recorded	Used in ceremonies for narcotic ef- fect
<i>Machua pomifera</i> (Raf.) Schneider	14399	Osage orange, boss d'arc	ohahupi'	Bows manufactured from branches; infusion of roots used in treat- ment of sore eyes

<i>Malvastrum coccineum</i> (Pursh.) A Gray	14450	Red false mallow	yakanatau	Infusion of plant used for reducing swellings
<i>Morus rubra</i> L.	14434	Red mulberry	etehup', sohoboko	Fruits eaten
<i>Nelumbo lutea</i> (Willd.) Pers ?	No specimen	Yellow lotus	ke'ata	Roots boiled and eaten
<i>Nymphaea advena</i> Ait. ?	No specimen	Yellow pond lily	ke'ata	Roots boiled and eaten
<i>Opuntia</i> sp. .	No specimen	Prickly-pear cactus	wokwesi	Fruits eaten
<i>Petalostemum purpureum</i> (Vent) Rydb	14409	Purple prairie clover	pakutsu	Roots chewed for sweet flavor
<i>Prosopis glandulosa</i> Torr	14447	Mesquite	namo'itsom, natsokwe	Meal from pods eaten, leaves used to neutralize stomach acidity
<i>Prunus angustifolia</i> Michx.	14444	Chickasaw plum	Not recorded	Fruits eaten fresh or stored
<i>Prunus</i> spp	No specimen	Wild plums	yuseka, early plum parawaseka, late summer plum kuseka, fall plum natson's, dried plum as it falls to the ground su kun, one particular plum e'takom	Fruits either eaten fresh or dried and stored for later use
<i>Psoralea hypogaea</i> Nutt ?	No specimen	Indian breadroot		Roots eaten raw

TABLE I (Concluded)

Scientific name	Catalog no	Common name	Comanche name	Comanche use
<i>Quercus marilandica</i> Muench	14442	Blackjack oak, barren oak	quluu p'	Acorns eaten, leaves used as cigarette wrappers
<i>Quercus</i> sp	No specimen	Oak	pasapom	Acorns eaten, trunks used for fence posts
<i>Rhus glabra</i> L.	14420	Smooth sumac	qumayo'	Fruits eaten by children, leaves added to tobacco for smoking
<i>Rhus trilobata</i> Nutt	14438	Ill-scented sumac, skunkbush	datap'	Bark used in treating colds
<i>Rubus odoratum</i> Wendl	14439	Wild currant	huafakoi	Fruits eaten
<i>Salix</i> sp. ( <i>Salix nigra</i> ?)	14445	Willow	ohashab'	Sores eyes treated with ashes
<i>Sapindus Drummondii</i> H & A	14452	Soapberry	stomitesna:	Arrows for <i>arates</i> game made from stems
<i>Smilax bona-nox</i> L	14414	Greenbrier	qamotson	Leaves used as cigarette wrappers
<i>Solanum</i> sp.	14424	Nightshade	darpotaten	Used in a general tonic and tuberculosis remedy
<i>Sophora secundiflora</i> (Orteg) Lag	No specimen	Mescal bean	Not recorded	Beans used as ornaments, possibly for ceremonial purposes
<i>Typha latifolia</i> L	No specimen	Cattail	pisbu m	No use known to informant
<i>Vitis</i> spp	No specimen	Wild grapes	Not recorded	Fruits eaten fresh or dried for storage
<i>Yucca louisianensis</i> Trelease	14418	Soapweed, yucca	mu mutai	Roots used as soap
<i>Zanthoxylum americanum</i> Mill.	14398	Prickly ash, toothache tree	kunanatau	Bark used as medicine for fever, sore throat, and toothache

Unidentified (fam. Cactaceae) *	No specimens	Cactus	eka mitsa	Probably eaten
Unidentified	14401		itae, jamayha	No use known to informant
Unidentified	No specimens		kusupoko	Berries eaten
Unidentified	14406		kusiwzina	No use known to informant
Unidentified	14426		mawitsak'	Decoction used in treatment of constipation and gonorrhea
Unidentified (fam. Labatae)	14423		nemeñisas	Leaves used as perfume
Unidentified	No specimens		paiyap	Roots roasted or boiled and eaten
Unidentified	14400		pehenatsu, pehex	Used to check menstrual discharge
Unidentified	14437		poiya	Decoction of leaves used in treatment of fever
Unidentified	No specimens		qatanarixka	"Roots" roasted in fire and eaten
Unidentified	No specimens		sehetsatana	Roots boiled or roasted and eaten
Unidentified	No specimens		tapaxko	Roots cooked with fat to make soup
Unidentified	No specimens		totox'd	Tubers eaten
Unidentified	No specimens		tsuns	Roots roasted and eaten
Unidentified (fam. Cactaceae)	No specimens	Cactus	Not recorded	Fruits eaten

\* Obtained in Texas

were preserved for later use. The manner of preparation and storage is of considerable interest.

The fruits of the persimmon (*Diospyros virginiana*) were eaten fresh or were dried and stored for future consumption. The persimmon was commonly used in this manner by various tribes in the southern prairies and in the Southeast, and it is frequently mentioned in early historical accounts. The common method of preparation for storage seems to have been to beat the ripe fruits to a pulp, remove the seeds, and dry the paste. The cakes thus formed were later softened in water and prepared in various ways for eating. The persimmon has achieved little commercial importance, but is still widely used and esteemed by Indians and whites wherever it is available. An informant also described a black persimmon (Comanche *dunaseika*) obtained in Texas and Mexico. This was doubtless the Mexican persimmon (*Brayodendron texanum*), which occurs from central Texas southwestward into Mexico.

The fruits of the mulberry (*Morus rubra*) were eaten fresh, when ripe, but no attempt was made to store them. This species is the one most generally preferred by Indians, from the Iroquois country to Kansas and Missouri and southward.

The fresh ripe fruits of two hawthorns or "haws" (*Crataegus* spp.) were eaten by the Comanche. According to an informant, one should shout like a wolf before partaking of them, or he will be sure to get stomach-ache and constipation. An indication of the wide use of *Crataegus* fruits is a list, compiled by Yanovsky (27, pp. 30-31), of eleven species used by various tribes of Indians from the eastern states to California and British Columbia.

The Comanche names for several wild "plums" were recorded, including designations for early plums, late summer plums, and fall plums. It is quite likely that some of the "plums" are wild cherries or chokecherries. Only one was collected, the Chickasaw plum (*Prunus angustifolia*). The fruits of this species were either eaten fresh or stored for winter use. Another kind of plum (Comanche: *su'kui*) was also said to be stored after the seeds had been removed and the fruits dried on a hide in the sun. Later they were boiled in water and eaten. In the winter the Indians sometimes obtained plums by tracking pack rats to their nests and taking the hoarded supply.

Several species of wild grapes (*Vitis* spp.) were available to the

Comanche and were either eaten fresh or dried in the sun and stored. The dried fruits were dampened, worked into cakes, and baked, fat sometimes being added in the process. Wild currants (*Ribes odoratum*) were eaten fresh, but were not preserved, as they were among many tribes. Another fruit (Comanche *kusi poko*) was not seen, but was described as being black, and round, like a grape, and was said to be eaten fresh. Children were reported to be very fond of the sour acid fruits of the sumac (*Rhus glabra*), and various species were eaten by Indians wherever sumac was available.

The berries of the juniper or red cedar (*Juniperus virginiana*) also served as food on occasion, the practice of eating juniper berries of various species being common among the Indians of the Southwest and elsewhere. The Comanche name for the red cedar was given as *ekawa.p'*, and it was explained that *eka* is the term for "red." No etymology of *wa.p* was obtained. To judge from Chamberlain's discussion (6, pp 63-64), *wap* seems to be a root word for "cedar" in the Shoshonean languages. If this is the case, then the Comanche term *ekawa.p'* is an exact equivalent of the colloquial English term "red cedar" for the same plant.

The succulent fruits of prickly-pear cactus (*Opuntia sp*) were eaten fresh and were also dried for winter use. No specimens were collected, but the descriptions by informants leave no doubt as to the identity of the plants. The spines were rubbed from the fruits designed for storage, the seeds removed, and the pears dried in the sun. Another cactus, also, was edible, but an informant stated that before eating its fruit one should take the red juice and paint a cross on his forehead to prevent consequent diarrhea. A third cactus (Comanche *eka mitsa*) was said to be obtained in Texas, but the notes do not mention whether or not it was a food plant.

The fruits of the southern hackberry (*Celtis laevigata*) were beaten, pits and all, into a pulp and mixed with fat. This mixture was rolled into balls, which were placed on the ends of sticks and roasted over a fire. The Pawnee had a similar method of preparing hackberries, but added parched corn as well as fat (7, p 76). Hackberries were commonly eaten by Indians of the Southeast, the Plains, and the Southwest, the usual practice being to consume pit and all. In this connection it is interesting to note that in chemical analyses of hackberries prepared in the Indian manner Yanovsky *et alii* (29) found not only considerable amounts of carbohydrates and protein

but also a high mineral content. The chief mineral constituent was calcium carbonate, which accounted for about one quarter of the dry weight of the fruits. It seems that the scanty-pulped, unpromising-appearing hackberry may have been a valuable element in the diet of the Indians.

The tuberous roots of the Indian potato or *camote de ratón* (*Hoffmanseggia Jamesii*) were eaten raw or were boiled. Roots of related species were similarly treated by the Apache and certain Pueblo Indians of the Southwest (3, p. 52, 4, p. 42).

The "roots" of another plant (Comanche, *tun'ha*) were said to be eaten fresh or after they had been peeled, dried in the sun, and pulverized. The plant, which was described as growing along with the mesquite, was not seen, but the description and the manner of use suggest that it was probably some member of the genus *Cymopterus*. This opinion is strengthened by the similarity of the Comanche name to the Gosiute term (*tu'ha*) for *Cymopterus montanus* (6, p. 96). A single species (*Cymopterus acaulis*) is listed as occurring in Oklahoma (23, p. 373).

Two kinds of "wild onions" were described. A large, sweet-flavored variety (Comanche *pakø.k*) was prepared by braiding the plants together and roasting over a fire. A smaller onion (Comanche *tʔdiekø.k*), with red flowers, was considered less desirable. Wild onions were commonly eaten by various tribes of Indians, and it is not unlikely that both these plants actually belong to the genus *Allium*. Several species occur in Oklahoma.

Another plant (Comanche *siko*) was said to have leaves somewhat like those of a wild onion and to have blue flowers. The "root" (bulb?), which is eaten raw, has a sweet taste. This description strongly suggests the camass or swamp sego (*Camassia esculenta*), an important food plant of the northern Plains and the Plateau regions. The Gosiute name *pa-si-go* (6, p. 30) and the Snake name *pasego* (1, p. 9) are somewhat similar to the *siko* of the Comanche. The Paiute name (*sego*) and the Gosiute name (*sigo*) (5, p. 498, 6, p. 30) for the Mariposa lily (*Calochortus spp.*) are even more similar to the Comanche term, but A. F. Chamberlain (5, p. 498) points out that the word *sego* in the Paiute language is a general term for bulbous roots. *Calochortus*, apparently, is eliminated because it does not have a blue flower and does not occur in Oklahoma (23). *Camassia esculenta* fits the description well and is available in Comanche

County (23, p 56), it is probably the plant to which the informant had reference

The underground portion of a plant (Comanche *e'kakoni*) described as "growing like a radish and having a root like a radish" was said to be peeled, and eaten raw. The "root" was further described as red and sweet-tasting. Except for the color, the plant might well be the widely used prairie turnip or *pomme blanche* (*Psoralea esculenta*) of the northern Plains. Grinnell (9, p 178) describes, however, the Cheyenne use of a related species (*Psoralea hypogaea*) the root of which is red and which bears the same Cheyenne name as the *pomme blanche*, with a prefix meaning "red." This latter plant occurs in southwestern Oklahoma and may be the one in question.

A plant (Comanche *totox'd*) resembling a small tomato bears a "root" (tuber?) about the size and shape of a walnut. This "root" is peeled before being eaten, the flesh is light in color. The description applies well to the wild potatoes (*Solanum Jamesi* and *Solanum Fendleri*) commonly used in the Southwest except that the plants are said to "appear in the spring and not last long." These wild potatoes are not listed in the flora of Oklahoma (23).

Several other plants which produced underground parts useful as food were mentioned by informants, and the Comanche names have been recorded. An herb (Comanche *taḥazko*) was collected in the spring, and the roots were cooked with fat to make a soup. A grayish vine (Comanche *tsuns*) grows deep and produces a root which is roasted after its thin skin has been removed. (This might be some species of *Smilax*.) A "root" described as "like a sweet potato" (Comanche *qstanarizka*) was said to grow in sandy places. This "root" is peeled and roasted. Another edible "root" which was compared to a potato has the Comanche name *sehelsutsina*. It was eaten either boiled or roasted. On the basis of its name and its use Hoebel (correspondence, April, 1939) suggests that this is the Indian potato, a plant which, he notes, "Grows in hills, flowers like Sweet William," and has "small white tubers, ripe in spring, [that are] boiled and eaten." Even with this description we are unable to suggest a specific identification.

A plant (Comanche *panyap*) was described as having a blossom like that of a sunflower, and edible "roots" prepared by roasting or boiling. This suggests the so-called Jerusalem artichoke (*Helianthus*



*tuberosus*), but some other plant might fit the description equally well. Hoebel (10) records three Shoshone food plants the names of which suggest a relationship to the Comanche *payap*. The first of these (Shoshone. *yep* or *muhayep*) has a single "root," grows in the hills, and is harvested in early March. The second (Shoshone *tumbiyep*, that is, "rock *yep*") grows in rocky outcrops. It is of interest to note here that Chamberlain (6, p. 46) gives the Gosiute term *tum-bo-up* (rock + root + plant) for plants growing over rocks. The third has the Shoshone name *payep*, meaning "big *yep*," which appears to be the Shoshone equivalent of the Comanche *payap*, it is described as having several large tubers.

The pod of the mesquite (*Prosopis glandulosa*) contains a considerable amount of gummy saccharine material, of which a number of analyses have been made. One of the more recent shows the beans to contain about twenty per cent sugar (28, p. 656). The Comanche crushed them in a mortar made of buffalo hide, using a pestle of mesquite wood. After the beans were crushed, the seeds were removed and the pods pounded to a fine meal, which was used alone or added to corn meal as a sweetening. A mush was prepared by mixing mesquite meal with marrow, and a drink (Comanche *pihi-sawanap*) was made by combining mesquite meal and corn meal in water. Whether or not this drink was allowed to ferment is not mentioned in the notes. The Comanche preparation and uses of the mesquite beans are almost identical with those of the Apache and the tribes of the Gila region of Arizona (3, pp. 43-44, 4, pp. 41, 53), where the mesquite was a staple food. Among these tribes a fermented beverage was prepared from the mesquite alone or from a mixture of mesquite and corn meal.

In times of scarcity the acorns of the blackjack oak (*Quercus marilandica*) were eaten. They were shelled and boiled, and might be stored for future use. The Comanche, unlike many other tribes, did not grind them into meal, but ate them whole. Castetter (3, p. 47) reports that certain of the Pueblos also boiled the kernels whole. Acorns were widely used as food by various tribes, particularly in the Southwest, the Southeast, and California, and among some Indians in the latter region they were the major food staple.

The roots of several plants were eaten or chewed merely for their flavor. These seem to have been chiefly in the nature of famine foods and food supplements rather than staples. The roots of a

thistle (*Cirsium undulatum*), the Comanche name of which was *tsn*, were eaten raw. This same species (listed as *Cnicus undulatus*) and others were used in much the same manner by the Gosiute (8, p. 56), who called the plants *tsn'ga* or *ts'na*. The Snake Indians ate the roots of a thistle (listed as *Cnicus eriocephalus*, 1, p. 10), which they called *tsmah*. Hoebel (10) gives the Shoshone name of another thistle as *ts'nina* and states that the root was eaten after being roasted in ashes. Its stalk, while young and tender, was eaten raw, and had the interestingly similar Shoshone name *ts'ngabok*. A plant not collected and not seen but described as a water lily furnished edible roots, which were prepared by boiling. Two plants of the water-lily family (*Nymphaeaceae*) which were widely used by Indians in this manner and which would have been available to the Comanche (23, pp. 144, 145) are the American lotus (*Nelumbo lutea*) and the yellow pond lily (*Nymphaea advena*). The plant in question was probably one of these. The roots of the button snakeroot (*Liatris punctata*) were chewed, the juice being swallowed for its rich fatty taste, and those of the sweet-flavored purple prairie clover (*Petalostemum purpureum*) were likewise relished. The roots of the purple prairie clover and the white prairie clover (*Petalostemum candidum*) were similarly used by the Ponca (7, p. 94), those of another prairie clover (*Petalostemum oligophyllum*) found favor among some of the Pueblo Indians of New Mexico (3, p. 33). The inner bark of a hawthorn (*Crataegus* sp.) was said to serve as a chewing gum.

The nuts of the pecan (*Carya illinoensis*) were eaten fresh or were stored, without preparation, for winter use, as were those of the black walnut (*Juglans nigra*). Native wild pecan trees are plentiful in the rich valleys of the Comanche county and southward, and the nuts were prized by the Indians. They have been adopted as a delicacy by the white man, also, and the produce of both wild and cultivated trees is today an item of considerable economic importance.

Most Indian tribes make considerable use of plants as salads or greens and also steep the leaves in water to prepare various beverages. It is surprising that the Comanche notes do not include a single plant used for greens, and mention only two whose leaves were utilized in making drinks. The leaves of bush clover (*Lespedeza capitata*) were boiled in water to furnish a tea. The other beverage was prepared from the foliage of a plant said to grow in damp places and to have red fruits. This description strongly suggests the mem-

bers of the genus *Ilex*, which were similarly used. The well-known "black drink" of the Southeastern Indians was prepared from *Ilex vomitoria*, *Ilex cassine*, and perhaps from other species. However, although four species of *Ilex* are listed for Oklahoma (23, pp. 299-300), their range is given as in the southeastern part of the state, and they perhaps do not occur near the Comanche reservation.

Hoebel's notes on the Shoshone (10) contain an interesting item to which we know no parallel. He records the use of a plant (Shoshone *po' int'*) which is described as similar to the maidenhair fern (*Adiantum* spp.). The minute orange "seeds [sporangia?]" in the leaves were threshed by rubbing the leaves between the hands, and were then winnowed, ground, and boiled in water for soup.

A number of Comanche plant medicines were recorded, for a rather wide variety of ailments. Most of these medicines seem to be in the nature of practical home remedies, and few have anything of magic or of ceremony about them. Chamberlain (6, p. 46) gives the Gosiute term for medicine as *na'-tsu*. It is interesting to note that a number of the Comanche names for important medicines have this ending.

The flowers of the sneezeweed (*Helenium microcephalum*) were broken up and inhaled to induce sneezing as an aid in the expulsion of afterbirth. These flowers were similarly used in clearing the nasal passages. It seems likely that the plant would be effective for such purposes, as it secretes a resin which Stemen and Meyers (23, p. 599) say is poisonous to some people, it causes a skin condition similar to that produced by poison oak (poison ivy). This resin in contact with the nasal membranes would probably induce sneezing.

Two other plants were said to be employed in obstetrical cases. A tea made from the root of an unidentified plant (Comanche *pehenatsu*) was drunk to check excessive menstrual discharge. The Arikara also use a root for this purpose, that of the mallow (*Malva coccinea*) triturated with the gum from the chokecherry and given as a drink (8, p. 74). After childbirth the Comanche woman was laid on a padding of plants of silvery wormwood (*Artemisia filifolia*) over hot coals. No explanation of this procedure was obtained; the plant was widely used, however, both medicinally and ceremonially, throughout the Plains region, and smoke from it was considered effective in purification.

Plant remedies played a part in the Comanche treatment of venereal diseases. The root of the thistle (*Cirsium undulatum*) was boiled and the liquid drunk in cases of gonorrhea. Another medicinal drink for gonorrhea was prepared by making an infusion of the stems of an unidentified plant (Comanche *mawitsak'*). Syphilitic sores were treated with the ashes of the stems of little bluestem grass (*Andropogon scoparius*).

Two plants were used by the Comanche, in much the same manner, for both toothache and sore throat. For toothache the root of the purple coneflower (*Echinacea sp.*) or the bark of the root of the prickly ash (*Zanthoxylum americanum*) was held against the tooth to relieve pain. In cases of sore throat the root of the coneflower was boiled in water and the liquid drunk, or the inner bark of the prickly ash was ground and placed in the throat. This similarity may indicate some association of tooth and throat troubles in the minds of the Comanche, but it very likely has no significance, since both plants were general cure-alls among various tribes. The Cheyenne utilized *Echinacea* for the same purposes, and the methods of application were only slightly different (9, p 188). *Echinacea* was an important medicinal plant among the tribes of the Missouri River region, where its use for toothache was identical with that of the Comanche, but no mention is made of it as a cure for sore throat (7, p 131).

Three plants were prescribed for the treatment of "sore eyes." The root of the Osage orange (*Maclura pomifera*) was boiled in water and the decoction used to bathe them, the stems of willow (*Salix sp.*) were burned and the eyes treated with the ashes, and the sap of the prickly poppy (*Argemone intermedia*) was administered to the eyes. It was said that in gathering this latter plant offerings in the form of beads or other objects were made to it.

A tea for "stomach trouble" was prepared from the roots of *Eriogonum longifolium*, and the leaves of mesquite (*Prosopis glandulosa*) were chewed, and the juice swallowed, to relieve acid stomach. A remedy for constipation was a drink made by boiling the stems of an unidentified plant (Comanche. *mawitsak'*).

The bark of the prickly ash (*Zanthoxylum americanum*) was mixed with water and the decoction drunk as a cure for fever. Two other plants were also specified for the treatment of fever. The leaves of one of these (Comanche *poiya*) were mixed with an herb (unknown

to the informant) and boiled, the brew being used both externally and internally. The stems of a sneezeweed (*Helenium autumnale*) were soaked in water, and the body was bathed with this liquid. As a cure for colds the bark of the sumac (*Rhus trilobata*) was chewed and the juice swallowed.

A few miscellaneous remedies remain to be described.<sup>4</sup> The leaves of snakeweed (*Gutierrezia sarothrae*) were mixed with some other substance (unknown to the informant) as a remedy for whooping cough, and the roots of the nightshade (*Solanum sp.*) were boiled and the decoction prescribed as a general tonic, particularly in cases of tuberculosis. An infusion for reducing swellings was made from the red false mallow (*Malvastrum coccineum*) steeped in water. The tribes of the Missouri River region employed this plant in a similar manner (7, p. 103). Their practice was to chew the roots and apply them to inflamed sores and wounds as a cooling and healing salve. The mucilaginous properties of the plant probably account for its use in this way. The roots of the dotted button snakeroot (*Liatris punctata*) were chewed and the juice swallowed as a cure for swollen testes. The leaves of the pecan (*Carya illinoensis*) or of the walnut (*Juglans nigra*), ground and rubbed on the affected part, were thought efficacious for ringworm.

The Comanche used the branches of the Osage orange (*Maclura pomifera*) in the manufacture of bows. This was the preferred wood for the making of bows throughout most of the Plains region. Since the Osage orange occurs in only a limited area, from southern Missouri to northern Texas, its wood became a valuable trade article. There are accounts telling of the great demand for it among tribes as far north as the Arikara and the Blackfoot and as far west as the Pueblos. John D. Hunter, who spent many years as a captive among the Indians of the Arkansas and Missouri country, says of the Osage orange (11, p. 173).

<sup>4</sup> Two nonvegetal Comanche medicines were also collected. Although these are not pertinent to a discussion of plant uses, they may be recorded briefly. One is the nest of some nondomestic bee (Comanche: *tipinatu*), composed of a gummy substance which gives off a pungent odor when heated. The nest was placed on the fire, its fumes, inhaled by one who was unconscious, were said to revive the person quickly. The other medicine is a white chalky mineral, apparently fossil bones (Comanche: *tsosht'stseus*), which was obtained from deposits and used in treating sprains and fractures. The Comanche considered this mineral to be the bones of Piamupits, a supernatural being.

They manufacture it into bows, which become articles of commerce, and are sometimes exchanged for peltries, etc. I knew a Sioux to give his horse for a single one, and among the upper tribes they frequently bring three or four beaver skins each. The tree is so highly valued, that they never destroy it, except when wanted for use, or in the territories of their enemies; in the latter case, they make its destruction as particular an object, as they do that of their game.

Since the Comanche were more or less in control of at least a part of the area in which the Osage orange grew they were doubtless in a position to profit through trading it to other tribes. The Tewa tribes of the Rio Grande valley specified the Comanche particularly as a source of their Osage orange bowwood (20, p. 68).

Marcy and McClellan (15, p. 98) describe the bows of the Comanche as being made of the tough and elastic wood of the Osage orange, "strengthened and reinforced with the sinews of the deer wrapped firmly around them." This brief and incomplete description suggests the sinew-backed bow which is classified by Mason (17, p. 638) as the "seized bow" and which had sinew "wrapped about" it, but Mason seems nowhere to describe this bow in detail, has no illustrations of it, and gives no distribution of it among American Indians. The description might also apply to the sinew-lined type of sinew-backed bow except that it does not mention the lining of sinew, often inconspicuous, which was usually bound on by transverse bands of sinew. The "Shoshonean or narrow" type of sinew-lined bow (17, pp. 638, 643, and Plates 61 and 79) may be indicated. This bow had its distribution among the Shoshonean tribes of the Great Basin and among the Apache, the Navajo, and the Pueblos, but, according to Mason, did not occur east of the Rocky Mountains (17, pp. 640, 643). Wissler (25, pp. 159-160), however, examined bows in the American Museum of Natural History from various Plains tribes and noted sinew-lined ones from some of the northern Plains tribes. He considered these intrusive from the sinew-backed bow area to the immediate west, supplementary to the self bow, and of exceptional occurrence. The Comanche bows which Wissler mentioned appear to have been of the simple, unbacked type. It does not seem likely that the Comanche bows mentioned by Marcy and McClellan were such, for Mason nowhere describes or illustrates self bows bound with sinew. Whether or not the bows seen by Marcy and McClellan were sinew-backed, and, if so, whether or not they were typical Comanche bows remain open questions. There is,

apparently, no doubt that the Comanche were in frequent contact with tribes using the sinew-lined bow, and that the tribes most closely related to the Comanche habitually used such bows

Arrow shafts were made from straight stems of the rough-leaved dogwood (*Cornus asperifolia*) This species was also the preferred arrow material of the tribes of the Missouri River region (7, p 108) Marcy and McClellan (15, p 98) describe the arrows of the Comanche as being "twenty inches long, of flexible wood, with a triangular point of iron at one end, and two feathers intersecting each other at right-angles, at the opposite extremity" They do not specify the material used for arrows further than by saying that it was "flexible wood" Arrows for the *aratai* game were made from the stems of the soapberry (*Sapindus Drummondii*) Wood for game sticks was obtained from the buttonbush (*Cephalanthus occidentalis*)

The leaves of the smooth sumac (*Rhus glabra*) were mixed with tobacco The addition of other plant materials to tobacco was a common practice among many tribes of Indians, the leaves of smooth sumac being widely used in this way Chamberlain (6, p 72) notes that this species was smoked by the Gosiute, and Gilmore (7, p 100) cites its use by the Indians of the Upper Missouri, but neither writer mentions its being mixed with tobacco McGuire (14, p 385) gives Marcy and McClellan (16, p 102) as his authorities for the following "Captain Marcy refers to the Comanche being extravagantly fond of smoking tobacco, which they call pah-mo, mixed with the leaves of sumac (*Rhus trilobata*)" West (24, p 107) accepts this without question and repeats it In neither the 1853 (15) nor the 1854 (16) edition of Marcy and McClellan are we able, however, to find this complete statement The passage on Comanche smoking in these volumes (15 and 16, p 102) is as follows "All of them [the Comanche] are extravagantly fond of tobacco, which they use for smoking, mixed with the dried leaves of the sumac, inhaling the smoke into their lungs and giving it out through the nostrils" Evidently the Comanche term for tobacco and the name of the particular species of sumac were taken by McGuire from some other source and not from Marcy and McClellan, as is implied It may be true that *Rhus trilobata* was smoked by the Comanche, but *Rhus glabra* was specified by our informants as the species which was smoked, and medicinal uses only were ascribed to the former We know of only one other reference to *Rhus trilobata* as a smoking material, that by

Grinnell (9, p 180) for the Cheyenne, but *Rhus glabra* was commonly used by many tribes of Indians. The latter is the sumac, which Schultes (21, p 138) mentions as used by the Kiowa.

The leaves of two plants were said to be employed as wrappings for cigarettes. One of these is the greenbrier (*Smilax bona-nox*), and the other the blackjack oak (*Quercus marilandica*). Our notes give no explicit occasions on which the leaves of the blackjack oak were made into cigarette wrappings, but this was doubtless done chiefly at peyote ceremonies based upon the religious use of the cactus. According to Schultes (21, p 138), this use of blackjack oak leaves (given as *Quercus nigra*) in the peyote ceremony is a common practice. La Barre (12, p 48) states that cornhusk cigarettes are standard in the Kiowa-Comanche peyote ceremony, but that the Comanche and the Shawnee sometimes employ the leaves of the blackjack oak. Opler (18, p 28) mentions the rolling of tobacco in oak leaves (species not given) or in cornhusk in the peyote ceremony of the Carrizo and the Lipan Apache.

Mr Carlson and the other members of the field party engaged in a Comanche peyote ceremony, but as this will be described in a later report and as a rather full account of the Kiowa-Comanche type of ceremony has recently appeared (12, pp 43-53), we need give little attention to peyote here. Formerly the Comanche doubtless obtained their peyote (*Lophophora Williamsii*) while they were on expeditions into its native habitat in the Rio Grande region of Texas and southward, but more recently they have acquired it by trade and have even cultivated it. La Barre (12, p 57) refers to an unpublished manuscript by Hoebel describing an early ritualistic Comanche expedition for peyote. Apparently the Comanche were also familiar with the mescal bean (*Sophora secundiflora*), which has a native range roughly similar to that of peyote. La Barre (12, pp. 105-109, 126-127) summarizes the data concerning this narcotic plant, which seems at one time to have been the center of a prepeyote narcotic cult and whose use has been retained in connection with magic and ornament, particularly in association with the peyote ceremony. Participants in the peyote ceremony witnessed by our party had red beans, which were probably mescal beans (but may have been *Erythrina*), on the fringes of their leggings. Skinner (22, p 261) describes Iowa leggings, ornamented with mescal beans, which he considered might be "of the modified Kiowa-Comanche



type generally affected by members of the Peyote cult among all Oklahoma tribes," and he also mentions (p 163) obtaining a necklace of mescal beans from the Iowa, but he does not connect either of these with the peyote ceremony Schultes (21, p 141) states that a Kiowa peyote leader wore mescal beans on the lower part of his leggings "as a safeguard against stepping on menstrual blood," and La Barre (12, p 45) observed mescal beans worn on Kiowa peyote moccasins for the same purpose La Barre (12, p 106) indicates an unpublished manuscript by Mooney as his source for the statement that the Comanche used to get mescal beans from near Fort Stanton (New Mexico), but apparently only for ornamental purposes

Our informants stated that in ceremonies the leaves of the red cedar or juniper (*Juniperus virginiana*) were placed on the fire and the smoke inhaled for purification Throughout the Plains the red cedar is associated with ceremonies and particularly with purification La Barre (12, pp 45-53) mentions several instances of the participation of a "Cedar-man" in the Kiowa-Comanche type of peyote rites The duties of this individual seem to be to sprinkle "dried and rubbed cedar" on the fire, and at certain stages the members purify themselves in the smoke from this incense Schultes (21, p 139) describes the typical manner of use of the cedar incense in peyote ceremonies

The Comanche brought great quantities of wormwood or "sage" (*Artemisia filifolia*) into the tipi for use as cushions There is a strong suggestion that they did this in the ceremonial tipi especially, where "sage" (*Artemisia spp*) was commonly employed as floor covering and cushions La Barre (12, p 45) mentions the spreading of sagebrush in the tipi for seats in the Kiowa-Comanche type of peyote ceremony and the resting of the "father peyote" on sprigs of sage (pp 46-47) Opler (18, pp 277, 279) says that the Carrizo and the Lipan Apache also strewed it on the floor and describes the placing of the "chief peyote" on it, for the peyote is considered to be friendly to no plant but this Schultes (21, pp 139-140) describes approximately the same uses of sage (the species *Artemisia vulgaris*) in the tipi, mentions the chewing of a few leaves of it before eating peyote, and also its place in the sweat lodge

Two other plants used by the Comanche in the sweat lodge are the skunkbush (*Rhus trilobata*) and little bluestem grass (*Andropogon scoparius*) The bark of the former was placed in hot water and the

fumes were inhaled. The stems of the latter were tied in bundles with which the Comanche switched themselves

*Yucca* roots (*Yucca louisianensis*) were ground up for soap. Various species were used as detergents by Indians in the Plains and the Southwest particularly. The ordinary method of preparation is to strip the bark off the root and beat the root to a pulpy mass. The pulp is cut into small pieces which are dried in the sun and can then be kept until needed. When required, two or three of these pieces are soaked in water for about an hour, after which the water is agitated briskly with the hands. Suds immediately appear, forming a good lather. The Southwestern Indians prescribe yucca suds for ceremonial hair washing and also prefer them for laundering blankets and woolen garments. The roots have a high saponin content, commercial soap has been successfully manufactured from them. Another plant used in toiletry was an unidentified species (Comanche *neméksas*) of the mint family, the fragrant leaves of which were valuable for perfuming.

The leaves of croton (*Croton monanthogynus*) were said to be ground and mixed with brains of animals for use in curing hides. This and other species of croton were widely utilized medicinally, but we know of no other instance of its employment in tanning. Richardson (19, p. 67) quotes two somewhat varying discussions of Comanche tanning, but in neither of these is any plant material mentioned.

Most tribes of Indians prepared brooms by binding together the tough and moderately flexible stems of some plant, but there seems to be little or no uniformity in the plants thus used. The one specified for this purpose by the Comanche was the snakeweed (*Gutierrezia sarothrae*).

Comanche names were obtained for all the plants collected, yet the informants, although knowing the names, could give no use for a number of them. Professor Kroeber has stressed the importance of collecting and recording negative data of this sort as well as positive data, and lists of "plants not used" have appeared in papers by his students. The Comanche informants could offer no use for the following plants: cattail (*Typha latifolia*), white sage (*Artemisia ludoviciana*), false indigo (*Amorpha angustifolia*), western ragweed (*Ambrosia psilostachya*), a grass (*Elymus* sp.), and two unidentified plants bearing the Comanche names *kuswána*, and *úse* or *íimayha*. It may well be that some or all of these were utilized and that their functions

were not known by the particular informants questioned. One man felt that the white sage had a practical value, but did not know what it might be. Some of these plants have been recorded as used by tribes more or less in contact with the Comanche and may have been employed in a similar manner by the Comanche. The informant who pointed out the western ragweed (*Ambrosia psilostachya*) gave its name as *woanatsu*, but knew of no use for it. The ending *natsu* indicates a medicinal plant, and it is interesting to note that this plant was prescribed by the Cheyenne in the treatment of colds, cramps in bowels, and bloody stools (9, p. 188), and that it was also valued by the Gosiute in the treatment of sore eyes (6, p. 49), but has a quite different name, without the *natsu* ending, in Gosiute.

The Comanche were formerly a very nomadic people, particularly after their acquisition of the horse. Marcy and McClellan (15, pp. 94-95) describe them as following the buffalo from place to place and also tell of their horse- and cattle-stealing expeditions, which covered over a thousand miles and even took them into the northern provinces of Mexico, consuming two years or more at a time. Richardson (19) tells something of the migrations, movements, expeditions, and contacts of the Comanche. They appear to have been in at least occasional touch with Apache and Pueblo Indians of the Southwest and with Plains and Plateau tribes as far north as what is now the Canadian border. It seems reasonable that they should have been an important agency in the diffusion of plants and of knowledge of plant uses as well as of other culture traits. They controlled practically all the limited area in which the valuable *bois d'arc* or bowwood grew and from which it was traded to the Siouan, the Caddoan, and other tribes to the north, and to the Pueblos to the west. They doubtless also were instrumental in spreading the narcotic cults based on the peyote and mescal beans. La Barre (12, p. 43) considers the Kiowa and the Comanche to be the center of diffusion of peyote in the Plains. Both peyote and mescal beans were native to the southwestern region of Texas and in Mexico, but were diffused almost throughout the Plains and as far northeastward as the Great Lakes. Certainly the many similar plant uses of the Comanche and of other tribes of the Plains, the Plateau, and the Southwest indicate either Comanche contact with these various peoples or a very active dissemination of such traits throughout these areas.

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## GREEK AND ROMAN REFERENCES TO THE NETTING OF QUAIL MIGRATING ACROSS THE MEDITERRANEAN SEA

EUGENE S. McCARTNEY

ANCIENT and modern lore about the migration of birds over the Mediterranean Sea makes fascinating reading, and it is not less interesting because of an occasional difficulty experienced in separating fact from fiction.<sup>1</sup> There are passages in both Greek and Latin which have to do, directly or indirectly, with the flight of quail over this great body of water. One of them, by Diodorus Siculus, means much more than is apparent on the surface, but its full import can be brought out when it is analyzed in the light of evidence provided by persons who have made careful observations of flights of quail. I shall discuss it in the second half of this paper.

It is said by a little-known Greek author<sup>2</sup> that quail crossed the Mediterranean Sea without stopping. A similar statement has been made of those that are seen in the Jordan Valley. "The quail always

<sup>1</sup> For instance, there are tales of small birds riding across this sea on the backs of large ones. A number of them have been collected by Ernest Ingersoll, *Birds in Legend, Fable, and Folklore* (New York and London: Longmans, Green and Co., 1923), pp. 83-88. But are current reports to the effect that hummingbirds migrate on the backs of geese true or just tall stories? One writer who made a conscientious effort to answer this question authoritatively had to acknowledge defeat. See A. Rutledge, "Titania of the Airways," *Coronet*, 5 (March, 1939): 117. Compare the guarded words of B. Johnson, "Consider the Ant," *The Atlantic Monthly*, 163 (1939): 410. "They tell me that there are a number of smaller birds that have taken to hitch-hiking. Hummingbirds in particular will thumb a ride on the back or under the wing of a larger bird to some distant flower garden, while other species cross wide bodies of water on the backs of wild ducks." The article "Ornithology" in the *Encyclopædia Britannica*,<sup>14</sup> XVI: 925, lists as a superstition the belief of southern European peasants that small birds are carried to Africa on the backs of storks and cranes. Several similar stories of aerial passengers, including the one about hummingbirds, are given by Frederick C. Lincoln, *The Migration of American Birds* (New York: Doubleday, Doran & Co., 1939), p. 9, who states (p. 11) that there is no scientific basis for them. He calls them "migration myths."

<sup>2</sup> Dionysius, *De Avibus* 1.30.

fly by night and do the Mediterranean in one stage, choosing the narrowest part"<sup>3</sup> Quail can fly great distances without stopping, but those that cross the wider parts of the Mediterranean naturally take advantage of opportunities to rest on islands in their line of flight, as they did in antiquity<sup>4</sup> Those that encounter storms and adverse winds make forced landings<sup>5</sup>

We are told that it was one of the duties of the priests who worshipped Zeus Aristaeus upon the mountain tops of the island of Cos to make entreaties to this deity to send wind by which quail might be entangled in nets<sup>6</sup> Such prayers must have represented the wishes of many islanders, for great numbers of quail made emergency stops on islands Perhaps clear weather might have enabled the quail to continue their flight without interruption — either temporary or permanent

A Roman writer records that the islands of Pontiae, Palmaria, and Pandateria, off the coast of Campania, were frequented for several days in both spring and fall by migrant quail and other birds<sup>7</sup>

From time immemorial enormous numbers of quail have stopped at Capri to rest during migration flights For centuries the bishop of this island depended for his income upon a tax levied on those who made a business of netting the birds, and so became known in Rome as "the quail bishop" (*il vescovo delle quaghe*) This information is to be found in the well-known book by Dr Axel Munthe, *The Story of San Michele*<sup>8</sup> He makes it very clear how seasonal netting of migrating birds can be a profitable occupation

They came in thousands woodpigeons, thrushes, turtle-doves, waders, quails, golden orioles, skylarks, nightingales, wagtails, chaffinches, swallows, warblers, redbreasts and many other tiny artists on their way to give spring concerts to the silent forests and fields in the north A couple of hours later they fluttered helplessly in the nets the cunning of man had stretched all over the

<sup>3</sup> The words of a hunter quoted by H V Morton, *In the Steps of the Master* (New York Dodd, Mead and Co, 1938), p 113

<sup>4</sup> See Pliny the Elder, *Nat Hist* 10 66 "Iter est his per hospitia certa"

<sup>5</sup> For a story of an island in the North Sea that is used as a haven by storm-driven birds see *The Americanization of Edward Bok* (New York Charles Scribner's Sons, 1921), pp xviii-xix.

<sup>6</sup> Callimachus, *Atta* 3 1. Page 209 in A W. Mair's edition in the Loeb Classical Library

<sup>7</sup> Varro, *De Agri Cultura* 3 5 7

<sup>8</sup> Chapter 28, pp. 454-461 This chapter is worthy of the attention of any classicist who is interested in birds. I consulted the 1930 edition of the book, published by E P Dutton and Company

island from the cliffs by the sea high up to the slopes of Monte Solaro and Monte Barbarosso. During six weeks of the spring and six weeks of the autumn, the whole slope of Monte Barbarosso was covered with nets from the ruined castle on the top down to the garden wall of San Michele at the foot of the mountain. It was considered the best *caccia* on the whole island, as often as not over a thousand birds were netted there in a single day.

Another airport that attracts birds in great numbers is the Asiago Plateau in northern Italy, where they stop on their southern migration. Exhausted by their long flight over the mountains, often against the wind and buffeting currents of air, they fall easy victims to netters (see Pls I-II), snarers (see Pl III), and gunners. So many are killed that some species are said to be threatened with extinction.

It seems somewhat anomalous that there are not more ancient records of the migration of birds over the Aegean Sea. We are informed, however, that flocks of quail sought the security of Delos and that for this reason the island was called Ortygia ("Quail Island")<sup>10</sup>. Presumably in antiquity migrant quail stopped at other islands also, as they do today. A half century ago they rested on the islands of Antiparos<sup>11</sup> and Santorin (Thera) and doubtless on many others.

Thera, as being the southernmost island in the [Greek] archipelago, is a favourite halting place for birds of passage in their various seasons before commencing their long flight. August, perhaps, when the quails pass by, is the busiest of these times, and then everyone is a sportsman, for the quails perfectly cover the plain and mountains. Guns and ammunition are expensive luxuries, reserved only for the well-to-do, so those whose means are limited go forth to

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\* Pp 457-458. Another record of the slaughter of birds on Capri may be found in a popular volume by Arthur Foley, *Italian Ports of Call* (Boston: Bruce Humphries, 1939), p. 127. "When the pheasants migrate from North Africa each year they fly in the direction of Capri by the thousands. The natives string up a large, wide rope net across the mountain section. The birds, flying blind at night, strike this net, which breaks their necks, and the natives gather these birds by the thousands, clean them, and prepare them for the markets of Italy."

The rotogravure section of *The Detroit News* for Sunday, February 14, 1937, has two excellent illustrations of the way bird catchers in central Europe lure migrants by the use of caged birds and trap them in nets. Plate II of this article is reproduced from the same source that the *News* employed for one illustration.

<sup>10</sup> Phanodemus, as quoted by Athenaeus 9.392 D. For a mythological explanation of the name "Ortygia" see Servius on Vergil, *Aeneid* 3.73.

<sup>11</sup> Bent, J. Theodore, *The Cyclades, or, Life among the Insular Greeks* (London: Longmans, Green and Co., 1885), p. 424.



the chase armed with long nets which they attach to the end of a bifurcated stick, then they stand behind walls and send dogs into the fields, and they catch quails like butterflies as they pass. During August you can buy a good fat quail for a penny in Santorin, they keep them for months on millet seed in upper rooms, and when they are fat enough they boil them with a little vinegar and salt, and put them by.<sup>12</sup>

The period of the present fall migrations over the eastern Mediterranean is much longer than that noted for Thera and Santorin a half century ago. In a very readable book called *Yesterday and To-day in Sinai*, by Mr C S Jarvis, who while governor of Sinai took advantage of opportunities to learn the habits of quail, there is an interesting, even if distressing, chapter on the netting of these birds. A very informative paragraph of this account, from which I shall have several occasions to quote, is as follows.

The quail, unfortunately for himself, is a migratory bird, and it is on his annual migration from his summer to his winter haunts that he lays himself open to capture. He breeds and spends the summer in the cornfields of Southern Russia, Roumania and Hungary, and then, when the young birds are full grown at the end of August, he begins his flight towards Africa. The migration starts during the last few days of August, and continues throughout September till about the middle of October.<sup>13</sup>

Mr Jarvis gives April as the date of the spring migration in Sinai.<sup>14</sup> On the island of Capri, as we have already seen (p 545), the netting of migrant birds proved profitable for six weeks during both spring and fall.

Quail do not begin their migrations unless conditions are propitious.<sup>15</sup> "Birds will undoubtedly not start on their flight across the sea if the wind is unfavourable, and although weather in the Mediterranean may be very local, there is generally a fair period of warning before strong winds, so that the chances are greater that birds will have a favourable passage, especially if the journey is not a very long one."<sup>16</sup>

Doubtless sheer exhaustion of migrant quail sometimes made the islands of the Aegean welcome havens for them. Mr Jarvis says that "odd individuals who have fallen out of the main body land on

<sup>12</sup> Bent, *op cit*, pp 126-128

<sup>13</sup> Jarvis, C S, *Yesterday and To-day in Sinai* (Boston and New York: Houghton Mifflin Company, 1932), p 259

<sup>14</sup> *Ibid*, p 183

<sup>15</sup> See an interesting paper by Rear Admiral Lynes, "Observations on the Migrations of Birds in the Mediterranean," *British Birds*, III (1909) 36-51, 69-77, 99-104, 133-150

<sup>16</sup> *Ibid*, p 140

vessels, and any ship arriving at Port Said during the months in question <sup>17</sup> will have several quails on board as stowaways <sup>18</sup>

In emergencies like those described in another paragraph from the same book <sup>19</sup> quail would have been glad to seek refuge on an island "During September there are frequent thunderstorms in the Mediterranean, accompanied by torrential downpours, and occasionally ships pass through masses of drowned quail who apparently have been drenched by the rain and [have become] unable to maintain their flight <sup>20</sup>

If Cos was on or near a migration route of quail there would have been several weeks during which certain heavy winds would have forced the birds to land there in numbers sufficient to make the netting of them a source of profit to many islanders. If it was only an emergency shelter the natives would naturally ask the priests to intercede with Zeus for winds unfavorable for the quail and favorable for the netters.

Aristotle <sup>21</sup> explains that quail are unable to fly during the prevalence of a southerly wind, which is wet and violent, and that for this reason bird catchers are on the alert for them while such a wind is blowing rather than during clear weather.

It will be recalled that it was the wind which caused quail to fall a prey to the Children of Israel after they had had a surfeit of manna.

And there went forth a wind <sup>22</sup> from the Lord, and brought quails from the sea, and let them fall by the camp, as it were a day's journey on this side, and as it were a day's journey on the other side, round about the camp, and as it were two cubits high upon the face of the earth.

And the people stood up all that day, and all that night, and all the next day, and they gathered <sup>23</sup> the quails. He that gathered least gathered ten homers, and they spread them all abroad for themselves round about the camp <sup>24</sup>

<sup>17</sup> That is, the last few days of August, all of September, and half of October. See p. 546.

<sup>18</sup> Jarvis, *op cit*, p. 280.

<sup>19</sup> *Ibid*.

<sup>20</sup> According to Rear Admiral Lynes, *op cit*, p. 142, sudden storms on the Mediterranean take a heavy toll of birds. On page 143 he tells how, when a storm was brewing on the afternoon and evening of April 29, 1906, while H M S *Venus* was fifty miles from the west end of Crete, there was a "tremendous visitation of migrants on board the ship."

<sup>21</sup> *De Animalibus Historia* 8.12.597b. Pliny, *Nat Hist* 10.66, copies Aristotle.

<sup>22</sup> According to Psalms lxxviii. 26, it was the east and south winds which brought the quail.

<sup>23</sup> See the comments of A. Goodrich-Freer (quoted on page 550) in regard to "gathering" quail.

<sup>24</sup> Numbers xi. 31-32. Compare Exodus xvi. 13. With the Biblical account

An exceedingly interesting passage in connection with the migration and the netting of quail is Diodorus Siculus 1 60 2-10 Actisanes, king of the Ethiopians, instituted a novel method of dealing with thieves. After cutting off their noses he settled them in a city on the border between Egypt and Syria at the edge of a desert.<sup>26</sup> He named the city Rhinocolura, because of the mutilated noses of the inhabitants. These people managed to get some aid in their struggle for existence by catching quail. The part of the account which describes the method of netting them (1 60 9-10) is thus translated in the Loeb Classical Library

And yet, despite the fact that they had been cast out into a desert country which lacked practically every useful thing, they contrived a way of living appropriate to the dearth about them, since nature forced them to devise every possible means to combat their destitution. For instance, by cutting down reeds in the neighbourhood and splitting them, they made long nets, which they set up along the beach for a distance of many stades and hunted quails, for these are driven in large coveys from the open sea, and in hunting them they caught a sufficient number to provide themselves with food.

The translator did not understand the implications of this account. If large *coveys* of quail had been driven in from the sea by the weather in numbers sufficient to provide food for even a small town, quail would have been exterminated very quickly in that region. Obviously the birds in question were migrants, like those which the north wind brought from the sea to the Children of Israel (Numbers xi 31). The situation is made perfectly plain by the words of a Biblical student who visited Palestine. "The wind blew quails in [according to the Biblical narrative], and that still happens regularly every year. Each September the quails blow in by multitudes from Cyprus over Gaza down the Wady el 'Arish. The inhabitants of Gaza suspend their ordinary occupations and catch

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of the miraculous appearance of quail compare a story having a setting in New England, as recorded by W. DeLoss Love, *The Fast and Thanksgiving Days of New England* (Boston and New York: Houghton, Mifflin and Co., 1895), p. 183. "In early times there were multitudes of wild pigeons in New England. They were so numerous in 1642 as to do great damage to the grain fields. Again they came in 1648, but as the harvest was mostly gathered there was little to destroy. Thousands were killed and used for food, upon which account Winthrop observes 'thus the Lord showed us that he could make the same creature, which formerly had been a great chastisement, now to become a great blessing.'"

<sup>26</sup> Compare Seneca, *De Ira* 3 20 1. "Sic rex Persarum totius populi nares recidit in Syria, unde Rhinocolura loco nomen est."

quails in nets as they fall wearied from their long flight, and the markets of Jerusalem are glutted with them"<sup>26</sup>

In a later quotation from the book by Mr Jarvis (see p 551) it will again become clear that ἀγέλαι as used by Diodorus means migrant flocks, not coveys

It seems to me that too much has been read into the account of Diodorus by Otto Keller,<sup>27</sup> who says that the transplanted Egyptians of Rhinocolura salted and exported quail The concluding words of Diodorus, "they caught a sufficient number to provide themselves with food," do not warrant such an inference

I am convinced that even Diodorus failed to grasp the full significance of his story, which he doubtless repeated from hearsay He leaves one under the impression that quail were almost a stable source of food supply,<sup>28</sup> but quail collect in enormous numbers only during migrations As already noted, Rhinocolura was on the sea between Egypt and Syria The conditions under which migrant quail come today to a long stretch of the shore of the southeastern Mediterranean are well described by Mr Jarvis (pp 169-170), who believes that in their wanderings after their flight from Egypt the Israelites passed across northern Sinai

The fourth and most convincing argument concerns the quails On two separate occasions — once after leaving Elim and once considerably later at Kibroth-Hattavah — the Israelites fed on the quails that came in from the sea in a cloud and settled near the camp This is a sight that may be seen to-day at almost any part of the Mediterranean coast [of Sinai] during the autumn migration In the months of September and October,<sup>29</sup> shortly after dawn on almost any day, one may see a cloud of quail coming in from the sea so completely exhausted that they pitch on the sea-shore and stagger into the nearest scrub for cover It is quite easy when the birds are in this condition to catch them by hand, and in a year when the migration is good it would be quite possible for a host as numerous as the Israelites to eat their fill, and it is also quite possible — the birds being extremely fat and oily — for a surfeit to cause gastric trouble, which apparently happened at Kibroth-Hattavah All this could quite easily happen to-day in North Sinai, but not in the south, where the quail is never seen, the migrating swarms of quail pitch on the Mediterranean shores and nowhere

<sup>26</sup> Fosdick, H E., *A Pilgrimage to Palestine* (New York The Macmillan Co, 1927), p 68

<sup>27</sup> *Die antike Tierwelt* (Leipzig W Engelmann, 1913), II 161

<sup>28</sup> Could the people of Rhinocolura have stood a steady diet of quail much better than the Israelites did? See Numbers xi 33-34 At present it does not take Arabs long to get a surfeit of quail. See the quotation from A. Goodrich-Freer on page 550

<sup>29</sup> Evidently till about the middle of October See the more precise dating given on page 546

else This in itself is sufficient argument to prove that the wanderings must of necessity have been in the north and not the south

Unless the thieves of Rhinocolura salted some quail, they could not have used them long as a staple food The quotation shows that they might have done so during a few weeks in the fall <sup>30</sup>

The thieves improvised reed nets,<sup>31</sup> which may have been ingenious, but it would seem that almost any kind of net would suffice to catch quail in the condition of those described by Mr Jarvis Another modern observer says that quail regularly arrive at the shore line only a few feet above the surface of the water <sup>32</sup> A German scientist in Palestine states that quail resting in Sinai and Southern Palestine after a long desert flight can generally be caught with the hand <sup>33</sup> Josephus,<sup>34</sup> who believes that the quail which the Israelites ate had come across the Arabian Gulf, likewise speaks of their exhaustion after a long flight

The utter weariness of quails after battling against an adverse wind is well illustrated by the following quotation

Early one morning, in September, an Arab left at our door [presumably in Jerusalem] the present of a couple of brace of fine fat quail, later another brought a basket full of live ones, by midday the salesmen arrived with quantities at a very low price When I went out I found our neighbours all around constructing temporary cages in which to keep live quail for future consumption It had happened that the quail, coming north from Egypt, through the Jordan Valley, and flying low, as is their habit, with the wind, had met a contrary wind and become so much exhausted that they fell down in immense numbers, and were so weary that the bedu had caught them with their hands and, as we read (Numbers xi, 31-32) "they gathered them" As in the case of the Israelites, the whole town soon became sick of the sight of quail, and let a great many of them

<sup>30</sup> According to Dr Munthe (see p 545), quail used to be netted on the island of Capri for six weeks in both spring and fall

<sup>31</sup> For a drawing showing ancient Egyptian methods of netting waterfowl see *The Illustrated London News*, CLXXVI (1930), 285.

<sup>32</sup> Lynes, *op cit*, p 69 When quail are far out at sea, however, they fly so high that they are not observed from the decks of vessels See Lynes, *op cit*, p 138, and Jarvis, *op cit*, pp 259-260 Dionysius, *De Avibus* 130, says that migrant quail sometimes dashed themselves against the sails of ships and were caught by sailors Perhaps such ships were near land Pliny, *Nat Hist* 10 65, informs us that flocks of quail approaching land were a menace to sailors because they flew against the sails of boats and submerged them If there is any basis for the most extravagant part of his tale perhaps the capsizing was due to efforts of the sailors to evade the great number of birds trying to settle upon their boats.

<sup>33</sup> Bodenheimer, F S, *Animal Life in Palestine* (Jerusalem: L. Mayer, 1935), p 143

<sup>34</sup> *Antiquitates Iudaearum* 8 1.5

fly. They ran about our garden for days, getting up their strength, and could easily have been "gathered" again. The Arabs call them *salwa*, which is, I believe, the scriptural name. Moreover, I was told that the people eviscerated and dried them in the sun, as did the Israelites.<sup>22</sup>

Diodorus tells us that the thieves made long nets which they set up on the beach for a distance of many *stadia*. Since exhausted migrating quail alight just as soon as possible the nets would naturally be close to the water. In such a position even crude improvised nets would doubtless make immense catches. The deadliness of nets near the water is shown by the following quotation from Jarvis (p. 262)

The Egyptian regulations decree that no net is to be erected within 500 yards of the shore in Sinai and 1,000 yards of the shore in the Western Desert, that every kilometre there is to be a gap of 100 yards in which no nets are erected, and netting is absolutely prohibited on a 25-mile stretch immediately to the east of Port Said. These regulations, which are strictly enforced, will prevent the complete extermination of the quail. In the past nets used to be erected within a yard or so of the sea, and the quail, dropping to within a few feet of the ground at the welcome sight of land, almost invariably was caught, and the number that escaped was probably less than 10 per cent.

It seems worth while to quote again from Mr. Jarvis to show how quail are netted today.

The Egyptian Arab employs two methods of catching quail — the big trammel-net and the small hand-net. The big net is stretched between poles 12 feet high and is a trammel made of very fine thread. For the benefit of those who do not know what a trammel is like, it is, briefly, a small mesh net stretched in front of a large mesh. The small mesh is about 1½ inch and the large mesh about 1½ foot, and the quail when he strikes the small mesh net in front carries it through one of the large meshes of the net behind and finds himself enclosed in a sort of bag that hangs down and prevents him from escaping.

The small hand-net is about a yard square and is used in much the same way as ferreters employ a net for rabbits. The quail when he lands is so completely exhausted that he staggers into the first bit of cover he sees and remains there for some hours, sometimes a whole day, resting. He invariably enters this cover — i. e. a small bush of desert scrub, from the shore-side and goes out to the south to continue his flight. The Arabs, therefore, adopt the simple expedient of putting small nets round the south side of every scrub bush, and when scrub does not exist make a series of tiny hides<sup>23</sup> of coarse grass open to the north and south. The quail does not appear to be overburdened with brains, and he blandly walks into these hides to rest and when he departs finds himself hopelessly entangled in the net on the other side. If the quail could be taught to

<sup>22</sup> Goodrich-Freer, A. (Mrs H. H. Spoer), *Arabs in Tent and Town* (New York: G. P. Putnam's Sons, 1924), p. 223.

<sup>23</sup> I. e. hiding places or coverts.

leave by the door by which he entered hundreds of thousands would save their lives

The big trammel-nets, however, account for far more. Erected as they are in the open desert they are, of course, quite conspicuous, but the birds invariably arrive in the uncertain light just after dawn, and, moreover, are so exhausted that probably they have not the strength to avoid it. Men, women and children are in attendance, passing up and down the nets, and immediately a bird is caught he is carefully removed and placed in a long shallow crate made of date-palm cane. <sup>27</sup>

Mr Jarvis states (p 264) that "it is no unusual thing for 50,000 unfortunate little victims to be exported in one day from Sinai alone." A work published three years later than Mr Jarvis's shows the effects of this wanton destruction of birds. "In 1908 Egypt exported 1,208,000 birds and only 535,000 in 1926. This decline is due purely to the general destruction of birds, of which man is guilty."<sup>28</sup>

The methods of the ancients in netting quail and other birds<sup>29</sup> were doubtless not so efficient as are those of today, but the quotations taken from the books by Dr Munthe and Mr Jarvis enable one to see very clearly that the inhabitants of certain islands of the Mediterranean and the thieves at Rhinocolura could have caught them in sufficient numbers to make them a welcome addition to their fare.

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<sup>27</sup> Jarvis, *op cit*, pp 260-261

<sup>28</sup> Bodenheimer, *loc cit*. Another record of enormous catches of quail in the past may be found in a volume by Ernest Protheroe, *New Illustrated Natural History of the World* (Garden City, New York: Garden City Publishing Co [1935]), p 360. "Live birds are imported into our country, often fifty thousand at a time. Shipped at Alexandria or Algiers for Marseilles, they are conveyed by rail across France in cages holding a hundred birds each. Attendants feed the captives on the way, and only a small percentage die during transit, and in this manner 200,000 quails a month reach Leadenhall Market alone."

<sup>29</sup> Travelers describe the catching of partridges by methods other than netting. In some of the Cyclades they have been chased by the islanders afoot until they became so exhausted that they could be taken with the hand. See James Emerson, *Letters from the Aegean* (London: Henry Colburn, 1929), II 21-22. In Crete they are lured into caves by a little train of food. See Aubyn Trevor-Battye, *Camping in Crete, with Notes upon the Animal and Plant Life of the Island* (London: Witherby and Company, 1913), pp 44-45. In Asia Minor they have been captured in pits dug along their path. See Henry J. Van Lennep, *Travels in Asia Minor* (London: John Murray, 1870), I 315.



'Authenticated News'

A bird snarers' hut on the Asiago Plateau in northern Italy. Two cages contain songbirds intended to attract others. The device held by the boy to the left is said to be used in chasing birds into nets.



Authenticated News

An artificial thicket, on the Asiago Plateau, in which songbirds confined in cages are used as lures.







"Authenticated News"

A bird netter unfastening a songbird caught in a net in an artificial thicket  
on the Asiago Plateau

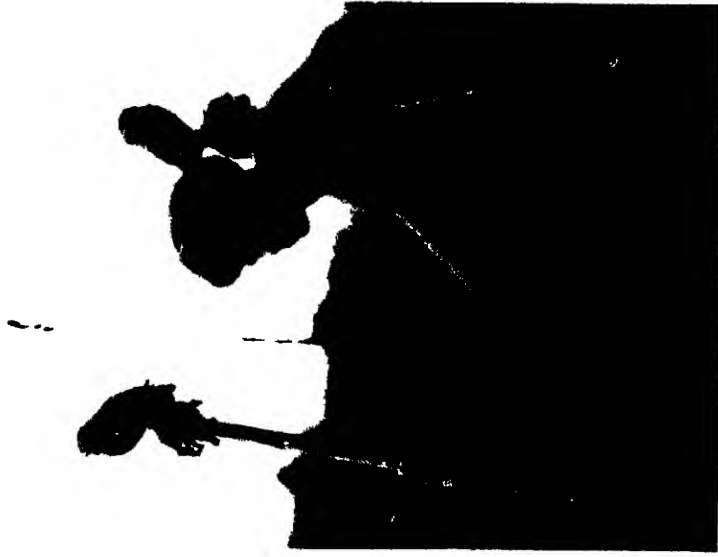




Swift News

FIG 1

The owls serve as lures for migrant birds on the Asago Plateau. The pointed sticks on the boy's back are thrown at the exhausted birds to keep them from taking off again. Boys become accomplished in this art which saves the expense of guns and ammunition.



Authenticated News

FIG 2

The pointed sticks on the boy's back are thrown at the exhausted birds to keep them from taking off again. Boys become accomplished in this art which saves the expense of guns and ammunition.



# SOME NOTES ON KINSHIP AND KINSHIP TERMINOLOGY AMONG THE POTAWATOMI OF THE HURON

GEORGE I QUIMBY, JR.

THE kinship data presented in this paper were obtained from five informants among the Huron band of the Potawatomi,<sup>1</sup> a small acculturated community of Indians in southern Calhoun County, Michigan. These data were collected on occasional weekend visits to the group during the years 1936 to 1938. In conducting the inquiry actual genealogies were used as far as possible, but they were extremely inadequate in their coverage of relationships. In lieu of such genealogies fictitious ones were employed, or the term for a given relationship was requested. These were checked at least twice, however, during the two-year period and were relatively free of inconsistency so far as a given individual was concerned.

Four of the informants, two men and two women, who constituted a majority of the eldest generation, were fifty years of age or older. The fifth was a younger man, who had been brought up by his paternal grandparents. These five people were bilingual. The intermediate generation knew the language imperfectly and seemed to be ignorant of the kinship terms. The youngest generations knew neither the language nor the kinship terms.

## HISTORY

The distribution of this band of Potawatomi in 1770 was as follows. There were six large cabins on the "Nandewine Sippy" (Huron River), five large cabins on the "Wandagon Sippy" (Saline Creek), and eight large cabins on the "Pasawapaco Sippy" (Kalamazoo River).<sup>2</sup> In 1821 the Potawatomi were placed on the Mendon Reservation in northeastern St. Joseph County, and in 1827 on the Notawasepe Reservation in southern Kalamazoo County.

<sup>1</sup> These Indians are mentioned by F. W. Hodge, *Handbook of American Indians North of Mexico*, Bur. Am. Ethnol., Bull. 30.

<sup>2</sup> *Michigan Pioneer and Historical Collections*, 15: 50.

About 1840 the United States Government attempted to move them to reservations in Kansas and Oklahoma. Troops were sent to convoy the Indians across the Mississippi. According to tradition, some of the Potawatomi escaped near St. Louis, Missouri, and returned to Calhoun County. Others, who had fled to Canada, also returned.

In 1848 the governor of Michigan, John L. Barry, purchased from the Federal Land Office 160 acres of land a few miles north of Athens in Calhoun County. This land was to be held in trust for the Potawatomi by the governor and by "his successors in office forever." At the present time the racially mixed, acculturated remnants of the Potawatomi of the Huron, about fifty people dwelling in nine cabins, live on this land tax-free.

#### THE CULTURAL OUTLINE, 1938

Any number of persons from one to nine occupy the one- or two-room cabins. These households consist of children, parents, grandparents, and relatives without families, in various combinations. The able-bodied men work in factories in Battle Creek or on WPA road gangs, or in season hire out to white farmers of the surrounding country. In the spring the women and a few of the men make baskets and brooms of hickory or elm, which they trade or sell to the merchants of Athens. Sometimes the elm is prepared for the weaving of baskets by both men and women, usually, however, the men merely cut the wood.

There is no political structure as such. The informants remember nothing of clanlike organizations, preferential marriage forms, and the like. Several of the older informants did recall a little about puberty rites. In the old days females were placed in a separate tent during their menses. Here, also, childbirth took place. When a boy was twelve or fourteen years of age he was taken to a special place, where he fasted for ten days, after which he usually had a vision.

According to another informant, there used to be "witches," shamans who could turn into animals at will. They wore on their chests such things as owl feathers and pieces of wolf and deer skin, and could, supposedly, fly through the air. These men, according to the informant, were agents of the Devil, whom the Indians then worshipped. The surviving tradition of puberty rites and of shaman-

ism might lead one to surmise that these complexes outlasted such things as the tribal or band organization, extended families, preferential marriage forms, and the like

Marriage usually takes place at about the age of sixteen to eighteen for girls and at about the age of eighteen to twenty-one for boys. Often, according to one informant, the girl is "in the family way," but, as he qualified it, this does not differ from the white man's way of marriage. There seems to be no social stigma attached to children born out of wedlock. The one case of illegitimacy observed was accepted without question by the community. Incest, following the European-American pattern, extends to the union of first cousins, but not of more distant relatives. With this exception, there seem to be no marriage restrictions or forms of preferential marriage practiced, nor are any remembered. This suggests that preferential marriage forms and exogamic organizations disappeared early in the contact period.

Racially these Potawatomi exhibit evidence of white admixture. At the present time there are no such mixed marriages, although marriage of a Potawatomi with a Negro has occurred fairly recently. The Negro did not seem to be satisfied in the community and moved away, taking his wife with him.

Inheritance follows the European-American form. One may leave wealth to whomever one desires, although property succession tends to follow the male line. Descent also is reckoned in the male line.

Land is owned by the heads of families. Since it is held in trust for the Indians, it cannot be legally sold. According to the informants, however, the Potawatomi do sell it among themselves, and it is heritable also. There are no visible boundaries, yet each family knows what land belongs to it, and the others appear to recognize this ownership. Land disputes seem to have been lacking in more recent times, perhaps because there is no attempt at intensive agriculture. Most families maintain only a small garden patch.

This land-ownership pattern does not seem to be greatly dissimilar to the so-called Algonquian band family hunting territory pattern. It might be the same form, surviving by virtue of its successful adaptation to several economies carried on in turn within a fixed territory, i.e. reservation land and land in trust. The system of ownership for a hunting domain could have been trans-



ferred to a smaller agricultural territory and later to a territory for the most part domiciliary. On the other hand, there need be no historical connection. The current land-ownership pattern could just as easily be an adjustment to the conditions dictated by the trusteeship.

The Potawatomi are Methodists and have been for some time, they seem to possess a feeling of aloofness in regard to the Catholic Potawatomi scattered to the southeast of them. There is a small chapel on the land at which services are held Sunday afternoons by a white preacher from the Methodist church at Athens. Supplementing his service is one in Potawatomi at which some of the elder informants officiate. Occasionally religious revivals are held entirely in Potawatomi.

Some of the elder Potawatomi believe in witches. According to one informant, the only way to kill a witch is by stabbing him through the heart with a knife made of cedar. There is still extant some of the old mythology, although it is well tempered with a long-established Christian tradition.

Formerly the children were educated at near-by Indian boarding schools or, infrequently, at western Indian schools. At the present time they attend a local country school or the high school at Athens. This situation causes some conflict with the surrounding white population, because the Indians use the schools but pay no land taxes. The young people speak no Potawatomi and tend to leave their homes as soon as they can get industrial jobs anywhere in the state or, in some instances, outside the state.

Medical aid and burial is provided by the county.

The preceding brief history and cultural outline are not intended to be complete. Their purpose is only to provide a rough frame of reference within which to view the changed kinship system.

#### KINSHIP AND KINSHIP TERMINOLOGY

The following kinship terminology was collected by Lewis H. Morgan,<sup>3</sup> in 1859, from Potawatomi on a Kansas reservation. The terms for the descendants of father's sister and mother's brother, lacking in Morgan's schedules, were taken from his data on the Ojibwa (Chippewa). He maintained that the kinship terminologies of the Ottawa, Ojibwa, and Potawatomi were identical except for

<sup>3</sup> Morgan, Lewis H., *Systems of Consanguinity and Affinity of the Human Family*, Smithsonian Contributions to Knowledge, Vol. 17, 1871.

slight dialectic differences His phonetic system is employed in the use of his data below, where "Ego" is a male (for the diagrammatic expression of this terminology see Chart I, p 559)

1 Grandfather and all his male siblings, and ascending generations	na-mo-sho-mis'
2 Grandmother and all her female siblings, and ascending generations	no-ko-mis'
3 Father	noss
4 Mother	n'geh
5 Father's brother	nok-mā'
6 Mother's sister	no-sheh'
7 Father's sister	n'si-gwis'
8 Mother's brother	n'jeh-shā'
9 Elder sibling, same sex	ne-sā-sā'
10 Elder sibling, opposite sex	n'mis-sā'
11 Younger sibling, either sex	ne-she-mā'
12 Father's brother's son and mother's sister's son	ne-kā'-na
13 Father's brother's daughter and mother's sister's daughter	n'dā-wa'-mā
14 Father's sister's son and mother's brother's son	ne-tā'-wis
15 Father's sister's daughter and mother's brother's daughter	ne-ne-moo-shā'
16 Son	n'gwis'
17 Daughter	n'da'-nis
18 Father's brother's son's son, mother's sister's son's son, brother's son	n'do-zhe-mā'
19 Father's brother's son's daughter, mother's sister's son's daughter, brother's daughter	n'do'-sha-mis
20 Father's brother's daughter's son, mother's sister's daughter's son, sister's son	nā'-gwi-nis
21 Father's brother's daughter's daughter, mother's sister's daughter's daughter, sister's daughter, father's sister's daughter's daughter, mother's brother's daughter's daughter	ne-she-mis'
22 Father's sister's son's son and mother's brother's son's son	n'do-zhim'
23 Father's sister's son's daughter and mother's brother's son's daughter	n'do'-zha-mi-kwem
24 Father's sister's daughter's son and mother's brother's daughter's son	ne-nin-gwi-nis'
25 All males and females in the next descending generation	no-sa-seh'

Some of the characteristics of this terminology are the separation of father, father's brother, mother, mother's sister, father's sister, and mother's brother Ego's male parallel cousins are classed together, as are his female parallel cousins, his male cross-cousins, and his female cross-cousins There is one term for Ego's elder brothers, another for his elder sisters, and another for his younger brothers

and sisters Morgan noticed, however, that this terminology was used only by the men. He believed, although his data were not sufficiently complete to indicate this clearly, that the women had a tendency to class father with father's brother, mother with mother's sister. There was a separate term for father's sister and mother's brother. Further, a female Ego classed the children of her father's brother and of her mother's sister with her brothers and sisters. She had a separate term for her male and her female cross-cousins.

The terminology that Morgan thought had been used by the women embodies the characteristics by which Spier,<sup>4</sup> in his classification of kinship systems, indicated his Iroquois type.<sup>5</sup> It seems unreasonable, furthermore, to assume that the Ottawa, Ojibwa, and Potawatomi differed from all other Great Lakes tribes, who, without exception, classed mother with mother's sister, father with father's brother, and parallel cousins with brothers and sisters. It is quite likely, on the contrary, that the Potawatomi terminology, uninfluenced by white contact, was a rather pure form of Spier's Iroquois type or, as Lowie calls it, "the bifurcate merging, [subclass] A"<sup>6</sup> type.

Then, if we assume that the precontact Potawatomi kinship terminology was the Iroquois type, we may suppose that the difference between it and the terminology collected in 1859 by Morgan at the Potawatomi reservation in Kansas is due to change brought about by white contact. Hypothetically the change might have resulted from the government's method of administering land and of distributing wealth to Indians on the reservation. This method would account for the tendency of the males to use isolating terms, since apportionments of land and wealth would have come to families through the males, and it would also account for the women's retention of the older terminology. At present, however, explanation of the way in which the difference arose is purely conjectural.

The direction of change in 1859 is from the Iroquois to the English type. The later terminology resembles the English type in

<sup>4</sup> Spier, Leslie, *The Distribution of Kinship Systems in North America*, University of Washington Publications in Anthropology, Vol I, No 2 1925.

<sup>5</sup> Spier classed the Potawatomi under his Iroquois type. In addition to Morgan's data he made use of terminologies collected by Alanson Skinner. Morgan considered the alignment of terms used by the men a recent introduction.

<sup>6</sup> Lowie, Robt H., "Relationship Terms," *Encyclopaedia Britannica*, 14th ed. (1929), 19 86.



that it has isolating terms for Ego's parental generation, and in that Ego's brother and sister are separated from their parallel cousins. Most of its other features are characteristic of the Iroquois type.

Data on the behavioral aspects of the kinship structure are lacking for 1859. Among the Potawatomi of the Huron in Michigan today there seem to be no behavioral attitudes connected with kinship other than respect for elders. This behavioral theme is emphasized by the Church and perhaps by the surrounding communities of whites.

At the present time kinship terminology<sup>7</sup> is as follows when "Ego" is a male (see Chart II)

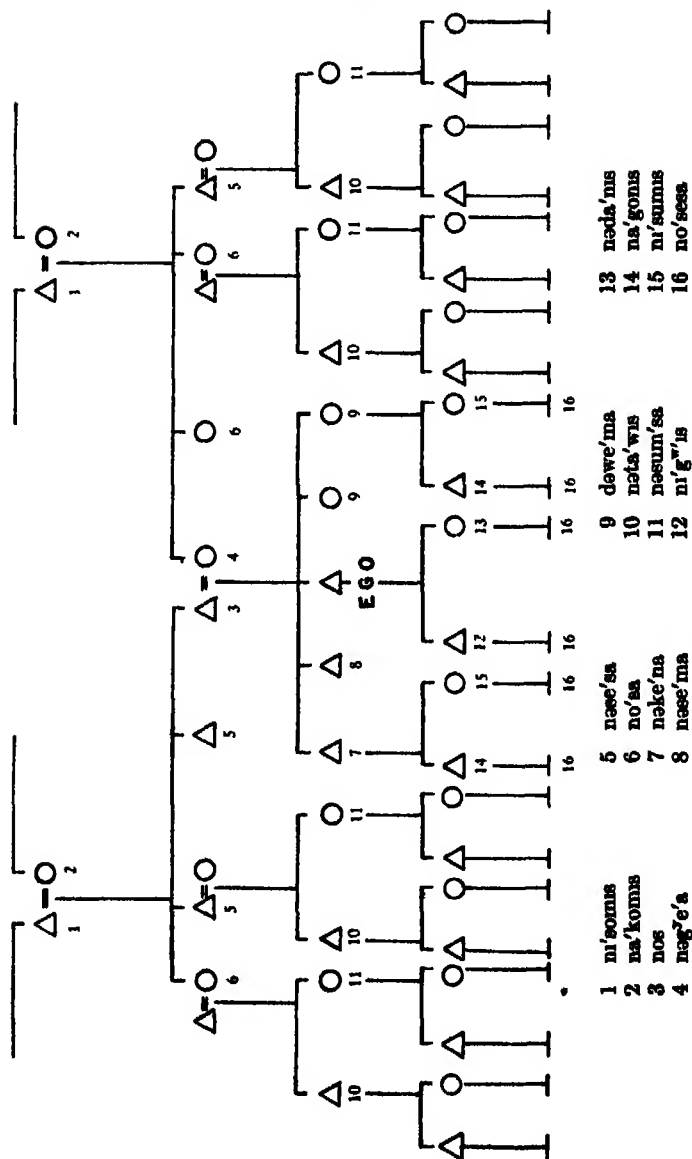
1 Grandfather	ni'somis
2 Grandmother	na'komis
3 Father	nos
4 Mother	neg'e'a
5 Father's brother and mother's brother	ness'sa
6 Father's sister and mother's sister	no'sa
7 Elder brother	neke'na
8 Younger brother	ness'ma
9 Sister, elder or younger	dowe'ma
10 Male cousin, parallel or cross	nota'wis
11 Female cousin, parallel or cross	nessum'sa
12 Son	ni'g'wis
13 Daughter	neda'nis
14 Brother's son and sister's son	na'gonis
15 Brother's daughter and sister's daughter	ni'sumis
16 Grandchildren	no'sesa

This terminology expresses biological relationships almost identical to those indicated by the English. The exceptions are the separate term for younger brother and the terms *ni'somis* and *na'komis* as applied by several informants to grandfather's siblings and to grandmother's siblings. Another informant, however, used the Potawatomi words for great-uncle or great-aunt to designate these siblings of his grandparents. The women use the same system as the men, although there is a shift in terminology in the case of certain reciprocal terms among siblings.

With the change from one type of kinship system to another there seems to have been an inexplicable shift in the terminology. For example, the word formerly used for mother's brother has be-

<sup>7</sup> The symbols used here are those recommended in the Smithsonian Miscellaneous Collections (Vol. 66, No. 6), with changes suggested by G. Hersog and others (*American Anthropologist*, 36, No. 4, 629-631).

## CHART II KINSHIP TERMINOLOGY



come the designation for mother's brother and father's brother, and, similarly, the one for mother's sister now designates mother's sister and father's sister. The term for male parallel cousins has become the designation for elder brothers, and the term for female parallel cousins the designation for elder or younger sisters, whereas the word for younger brother or sister has kept its older meaning for younger brother, but is no longer used for younger sister.

The term once designating male cross-cousins is now applied to all male cousins, and a term similar to that once used for female cross-cousins is now applied to all female cousins.

The word formerly denoting father's brother's daughter's son, mother's sister's daughter's son, and sister's son is now used to designate brother's son and sister's son. The word once used for father's brother's daughter's daughter, mother's sister's daughter's daughter, sister's daughter, father's sister's daughter's daughter, and mother's brother's daughter's daughter now applies to brother's daughter and sister's daughter.

The terms for grandfather, grandmother, father, mother, son, daughter, and grandchildren have been retained, but have become isolating (with the exception of that for grandchild). The other designations have been dropped completely.

The present-day terminology seems to represent the vestiges of a kinship structure which went through a number of changes because of white-culture contact and finally became identical with the English system. At the present time there appears to be no particular use made of this terminology, and it is doomed to disappear with the death of the older generation of the Potawatomi of the Huron.

#### SUMMARY

The kinship structure of the Potawatomi has changed from a classificatory bifurcate merging or Iroquois type of system to the isolating English type. Data upon the behavioral usages with reference to the former system are lacking. Morgan's 1859 kinship schedules suggest that at that time, because of factors introduced by white contact, the kinship terminology of the men was tending toward the English system, whereas that of the women kept closer to the original. By 1937, or before, both the men and the women were using the English system of kinship classification with a transference of Potawatomi terms from former categories to new ones.

wherever applicable. The shifts in terminology from one system to the other do not, however, seem to follow any regular pattern. It is possible that factors other than those noted may have influenced these shifts.

Considerable work remains to be done, especially with documentary sources, before a complete understanding of Potawatomi kinship structure and Potawatomi kinship terminology is possible. But, since the author is not in a position to continue this study at present, he wishes to record what has already been achieved, even though the data are incomplete.

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# **LANGUAGE AND LITERATURE**



## SAINTE-BEUVE AND CHATEAUBRIAND IN 1834

ANDRÉ B. DELATTRE

THE first important article by Sainte-Beuve on Chateaubriand was published on April 15, 1834, in *La Revue des deux mondes*.<sup>1</sup> It deals with the *Mémoires d'outre-tombe*, which Chateaubriand was then reading to a few friends in the salon of Mme Récamier at l'Abbaye-aux-Bois. Later on, after Chateaubriand's death, Sainte-Beuve published a two-volume work on him, as well as several additional articles,<sup>2</sup> altogether Sainte-Beuve wrote more about Chateaubriand than he did about any other contemporary writer. He has been accused by Pontmartin,<sup>3</sup> by l'abbé Bertrin,<sup>4</sup> and by quite a few others of having been hard and unjust toward Chateaubriand after he died, though he had flattered him during his lifetime. In the light of such accusations it may be interesting to study the circumstances in which Sainte-Beuve came to write his first major article on the author of *René*.

The relations between the two writers before 1834 may be summed up very briefly. When Sainte-Beuve broke away in 1828 and 1829 from the Idéologues and the Doctrinaires to join the Romanticists, Chateaubriand became the object of his enthusiasm, together with Victor Hugo, Vigny, and Lamartine. The critic met him in July, 1829, and visited him quite frequently in the winter of 1829-30.<sup>5</sup> Chateaubriand was not very well disposed toward the younger Romanticists. When he persisted in sulking at the most brilliant flowering of lyrical works yet produced in French literature, Sainte-Beuve classified him as a hopeless *passéiste*, in polite hints advised that he should retire, and in fact pronounced his retirement

<sup>1</sup> Cf. Sainte-Beuve, Charles Augustin, *Portraits contemporains*, I 7-44.

<sup>2</sup> *Chateaubriand et son groupe littéraire* (Paris: Garnier, 1861), 2 vols., *Causeries du lundi*, I 432-452, II 142-162, 539-564, X 74-90, *Nouveaux lundis*, III 1-34.

<sup>3</sup> Pontmartin, Armand de, *Nouveaux samedis* (Paris: Lévy, 1878), IX 245.

<sup>4</sup> Bertrin, G., *La Sincérité religieuse de Chateaubriand* (Paris: Lecoffre, 1900), pp. 28-72.

<sup>5</sup> Sainte-Beuve, *Portraits contemporains*, I 76.

an accomplished fact. On September 25, 1831, in an article on l'abbé Prévost, Sainte-Beuve observes that Prévost, the author of over a hundred tiresome and unreadable novels, would be today entirely forgotten if it were not for *Manon Lescaut*, and, boldly, he applies the parallel to Chateaubriand. With the exception of the solitary tower of *René* what is there in the vast structure of his works which is not crumbling? <sup>6</sup>

Chateaubriand, even if he was past sixty, had no thought whatever of withdrawing from the public scene, although almost every one of his works for the past twenty-five years — since *Les Martyrs* in 1809 — had included a pathetic adieu to life and literature.

Besides, in order to live in retirement, money was still needed, and Chateaubriand was wrestling with the most pressing financial difficulties. We shall see that those financial troubles had a very close connection with the reading of the *Mémoires* at the house of Mme Récamier in 1834.

When he had resigned, in 1829, from his position as French ambassador to Rome, he was in debt for several hundred thousand francs, and, until the Revolution of 1830, his only income was the twelve thousand francs he received as a member of the House of Peers. After the Revolution of 1830 that income disappeared. Chateaubriand would not pronounce the oath of allegiance to King Louis-Philippe and refused to accept any pension whatsoever from the new government. He even renounced the little indemnity he should have received as a member of the French Academy.<sup>7</sup> His pen remained his only means of livelihood. Up at six o'clock every morning, working twelve or fifteen hours a day, he started again as if he were an unknown young writer. In April, 1831, he published his *Études historiques*, four huge volumes of rambling essays on Roman and French history. They were the flattest failure he ever produced. The bankruptcy of Ladvocat, his publisher, in July, 1832, was another blow. The problem of Chateaubriand's future became more distressing than it had ever been since, poor and unknown, he had returned from England in 1800. At sixty-three years of age he still had to struggle in order to earn a living and also, if he were to believe the younger generation, in order to survive.

<sup>6</sup> Cf. Sainte-Beuve, *Portraits littéraires*, I: 268.

<sup>7</sup> Levailant, Maurice, *Chateaubriand, Mme Récamier et les Mémoires d'outre-tombe* (Paris: Delagrave, 1936), p. 7.

In 1809 he had undertaken to write his *Mémoires* and had since pursued that task in a very leisurely way. In May, 1831, after the failure of the *Études historiques*, he came back to the *Mémoires* and, for his subsistence as well as for his reputation, staked all his hopes on that work.

Of course the *Mémoires d'outre-tombe* was to be published only after his death. But in November, 1833, the first eighteen books were completed. It surely represented a certain capital. Could not an account on it be obtained from some publisher?

Since 1817 the life of Mme Récamier had been a constant effort to smooth the path for Chateaubriand. Her endless devotion was now about to conduct for his benefit one of the cleverest publicity campaigns in the nineteenth century. Sainte-Beuve and Mme Récamier became acquainted through Jean-Jacques Ampère, their common friend.<sup>a</sup> Sainte-Beuve put up a prolonged resistance, objecting that his remarks of September, 1831, concerning Chateaubriand (in the article on l'abbé Prévost mentioned above) made a *rapprochement* difficult. He was told that those remarks were forgiven and forgotten, and, in all probability in October or November of 1833, he started visiting the salon of Mme Récamier at l'Abbaye-aux-Bois, to which Chateaubriand came every afternoon.

The memoirs were read there in the latter part of February and in the first part of March, 1834. Maurice Levallant has given the most detailed information which we have of those readings.<sup>b</sup> They probably began, he says, on February 23, they ended on March 10. The eighteen books were read in twelve séances, at the rate of a book and a half a sitting. About fifteen persons were invited, among them were a number of critics (the most important of whom was Sainte-Beuve), several newspaper directors, and some of the aristocratic friends of Mme Récamier: the Duke of La Rochefoucauld, the Duke of Montmorency, the Duke of Noailles. On March 1, while the memoirs were still being read, an article was published on them in *La Revue de Paris* by Jules Janin. Janin had not been invited to the readings; he obtained his information indirectly, probably from Edgar Quinet. The tone of the article was one of delirious admiration. Janin concluded that English speculators had bought or were on the point of buying the *Mémoires*, and he deplored

<sup>a</sup> Sainte-Beuve, *Portraits contemporains*, I 77

<sup>b</sup> Levallant, *op. cit.*, pp. 225 ff.

that no French publisher had enough patriotic pride or at least enough business sense to snatch them from Chateaubriand <sup>10</sup>

The two main reviews in Paris at the time were *La Revue des deux mondes*, for which Sainte-Beuve wrote, and *La Revue de Paris*. Buloz, the editor of *La Revue des deux mondes*, felt he was being outdone. As Sainte-Beuve refused to write his article before he had heard the *Mémoires* to the end, Mme Récamier advised Buloz to ask Chateaubriand for excerpts of the *Mémoires*, Buloz wrote, accordingly, on March 10, and on March 15, 1834, *La Revue des deux mondes* published the preface of the *Mémoires*. *La Revue de Paris*, in its turn, begged Chateaubriand not to treat them worse than he did their rival, they obtained leave to publish a passage from the sixth book, "Ma Traversée en Amérique," which appeared with an article by Edgar Quinet. At the request of *Le Journal des débats* Chateaubriand gave that newspaper a fragment also, since, he said, he was beginning to realize that his work was no longer a secret. Other fragments appeared in *La Revue du midi*, *La Quotidienne*, and *Le Journal des femmes*. On April 24, however, the era of the strategic indiscretions was closed, on that date Chateaubriand turned down a minor magazine. "'My *Mémoires*,' he argued, 'are not to be published until after my death, if I made them known during my lifetime, it would be a deviation from my purpose'" <sup>11</sup>

Reviews, newspapers, and salons talked of nothing but the *Mémoires* in March and April. Some financial propositions were offered him in March, which he considered unsatisfactory and turned down.

Unfortunately for Chateaubriand, on May 2, 1834, a small book came out which monopolized all public interest and swept the country with cyclonic fury; *Les Paroles d'un croyant* by Félicité de Lamennais was the greatest publishing success of the first part of the nineteenth century; it has been said that hundreds of thousands of copies were sold within a few months.

Chateaubriand collected in October, 1834, all the articles written concerning the *Mémoires* and all the excerpts that had been printed, and published them in book form, *Lectures des Mémoires*, with a preface by Nisard. In a very melancholy mood he resumed his work on two potboilers, his translation of Milton and the *Essay on English Literature*.

<sup>10</sup> Levallant, *op cit*, p. 226.

<sup>11</sup> *Ibid.*, p. 231.

It was only two years later, in April, 1836, that a syndicate was finally organized to finance the purchase of the *Mémoires d'outre-tombe*, the debts of Chateaubriand were paid, and he obtained a life annuity of twelve thousand francs. But the eternal malcontent bitterly protested until his last days the indignity of having to "mortgage his tomb."

As for the article by Sainte-Beuve and the sincerity or flattery of its contents, without a doubt the critic writes as the grateful guest of the incomparable hostess who was watching over the glory of Chateaubriand. Also, Chateaubriand had allowed him the unique privilege of reading at leisure by himself the entire manuscript and of freely taking notes from it.<sup>12</sup> Yet we must notice that in the vast chorus of praise which arose in 1834 and which is recorded in the volume *Lectures des Mémoires*, the article by Sainte-Beuve is the most reserved, and the only one which attempts a general psychological study of the author. Sainte-Beuve wrote a very favorable article, but it can be called in no way subservient; it shows no lack of independent judgment.

A few years ago it was established that Chateaubriand and Mme Récamier insisted that Sainte-Beuve should write a second article, and that he refused to do so.<sup>13</sup> As has been disclosed by a letter that M. Bonnerot published lately, they kept insisting for several months, and as late as September, 1834, Sainte-Beuve wrote "Je me décide de plus en plus à me sauver par le silence de l'embarras de l'article sur M. de Chateaubriand."<sup>14</sup>

In 1836, when Chateaubriand published his translation of Milton and his *Essay on English Literature*, Sainte-Beuve was once more solicited for an article, but he considered those two works inferior and refused again,<sup>15</sup> in spite of what Mr. Victor Giraud may have said to the contrary.<sup>16</sup>

In 1834 and thereafter Sainte-Beuve's frame of mind was quite different from what it had been in 1829 and 1830. He never was to

<sup>12</sup> These notes have been published by J. Troubat in *La Revue d'histoire littéraire*, 1900, pp. 382-408.

<sup>13</sup> Letter of Chateaubriand to Bulox, April 25, 1834. "Si M. Sainte-Beuve faisait un second article, les citations qu'il pourrait désirer sont à sa disposition." *Cent Ans de vie française à la Revue des deux mondes* (Paris, 1929).

<sup>14</sup> Bonnerot, Jean, *Correspondances générales de Sainte-Beuve* (Paris: Stock, 1935), I: 468, "Lettre à Charles Magnin, 28 septembre 1834."

<sup>15</sup> Cf. Sainte-Beuve, *Portraits contemporains*, I, 80.

<sup>16</sup> Cf. *La Revue d'histoire littéraire*, 1928, pp. 441-444. *La Revue des deux*



become as heatedly enthusiastic and as full-heartedly devoted to furthering the glory of any contemporary writer as he had been in the case of Hugo and of Lamartine. The article of 1834 on Chateaubriand is not, as Béranger hinted it was at the time,<sup>17</sup> a switching of allegiance from Victor Hugo to Chateaubriand. Sainte-Beuve was never again to be a disciple to any one

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*mondes* of January 1, 1836, contains a few pages by Chateaubriand on Shakespeare (which were later published in the *Essay on English Literature*). These pages in *La Revue des deux mondes* are preceded by an anonymous introduction of twenty lines or so. Mr Giraud supposes this introductory note to be by Sainte-Beuve, and concludes that Sainte-Beuve did not speak truthfully when he said he had refused to write an article on the translation of Milton and on the *Essay on English Literature*. It may be answered that it is possible but by no means evident that the twenty lines of introduction are from Sainte-Beuve's pen. Besides, they were published in January, 1836, they precede by six months the volumes by Chateaubriand the translation of Milton's *Paradise Lost* and the *Essay on English Literature* were published in June, 1836. And Sainte-Beuve merely states that he did not write any article on the volumes (*Portraits contemporains*, I 80).

<sup>17</sup> Letter of Pierre Béranger to Napoléon Poyrat, April 22, 1834. "Hugo, qui n'a plus que les *Débats*, vient de se brouiller avec Sainte-Beuve qui s'est réconcilié avec Chateaubriand, qu'autrefois il accusait de jalousie contre le chef de la jeune école." Quoted by Sainte-Beuve, *Portraits contemporains*, I 78.

The break between Sainte-Beuve and Hugo took place on April 6, 1834. Cf Bonnerot, *op cit*, I 427-428.

## "I THOUGHT SO THEN"

— *Othello* V ii 192

AMOS R MORRIS

EMILIA of Shakespeare's *Othello* I have met frequently in daily life, and I have found her always a charming woman; I have never seen her on the stage. Not much has been said of Emilia by the critics, and most of what has been said does not make sense. Little has been made of the part on the stage, and that little is always wrong. Yet the part has greater possibilities as character than has that of Desdemona for the simple reason that Emilia is a fully developed woman, Desdemona is, if the brutal truth were told, only a blundering, dainty, and lovable doll. The stage tradition has not varied widely from the character portrayed by Mrs Jameson. "Emilia in this play is a perfect portrait from common life, a masterpiece in the Flemish style, and though not necessary as a contrast, it cannot be but that the thorough vulgarity, the loose principles of this plebeian woman, united to a high degree of spirit, energetic feeling, strong sense, and low cunning, serve to put in brighter relief the exquisite refinement, the moral grace, the unblemished truth, and the soft submission of Desdemona." Schlegel sees Emilia in much the same light, as "a companion of doubtful virtue." Only in such a character can he find an adequate explanation of the series of events centering round the disappearance of the handkerchief. His reference to "the sinful levity of this woman" gives him away, where sin and levity are, no virtue can be, a sinner will break all the laws of God and man. Anything is easily explained in so simple a system as that.

No rounded-out analysis of the character of Emilia can be undertaken here, the purpose is to interpret a sentence of only four words, less than half a line. But no interpretation can have meaning unless it fits into the background pattern of the whole character. The failure to understand the character of Emilia grows out of a whole series of misconceptions. Not least of these is the relationship

of Desdemona and Emilia as the wives of two military officers Emilia is somewhat older than Desdemona, probably in the early years of "the dangerous thirties" She is a member of the military set; she knows the ropes Othello and Cassio were bachelors, Emilia was therefore the ranking woman of the military set until she was supplanted in that position by Desdemona, after that she is second in rank The general's wife is young, entirely unsophisticated and childlike, has no mature understanding of the normal relations of men and women anywhere, and in particular no idea of army life and the place of the commanding officer's wife in the social system of which she is suddenly made the head Emilia knows her way around, is the only confidante of Desdemona and the one person from whom Desdemona can learn the duties and responsibilities of her new position as a wife and as the wife of the commanding officer The three officers have served together for some time Emilia is well known to Othello and Cassio, and that she has the respect of her husband, of Cassio, and of Othello there is abundant evidence From Caesar's wife to Bromberg's bride no social set has ever been more jealous of its reputation than has the military clique The sort of woman the critics and the actors have had in mind simply could not make the grade

That Emilia is no Portia or Beatrice is perfectly obvious That she was grossly stupid does not appear Her intellectual processes were, probably, about normal and average, in both speed and penetration When finally she sees the necessity for understanding what is going on, she puts two and two together quite as accurately and as rapidly as does anyone else in the play except Iago It would not be difficult to show that she has about the best brains in the party, after Iago. And she is a good match for her husband. But for the moment our interest is only in the interpretation of her statement, "I thought so then" Just what did she think, and when? The dramatic situation is made to order for the psychologist It is as apt to his purpose as if he had invented it himself. When she realizes that she is facing a crisis and has to think, she puts her head to it in perfectly normal fashion. Her thought processes are entirely clear and can be as definitely followed as under the controlled conditions of a laboratory demonstration

In the space of eighty-three lines (V. ii 135-218) we see illustrated two distinct types of thinking, each a perfectly clear organi-

zation in itself The first (lines 135-196) is an excellent example of cumulative organization, a progressive series of rearrangements, a filling in of details of a mental configuration, clear in a general way with line 135 and requiring no fundamental reorganization This type of thinking the psychologist would probably call *understanding* as distinguished from *reasoning*<sup>1</sup> The second (lines 213-218) is a distinctly different mental process It involves a new interpretation of all the elements of the first *Gestalt* in the light of a new element of the complex that gives to all parts of the former organization a new meaning This is the insight which the psychologist sees as the characteristic mark of *reasoning* as distinguished from *understanding* While Emilia is concentrating attention upon the deception and villainy she has been suspecting, she is merely clearing up her *understanding*; when to this is added the element of the handkerchief, everything takes on instantly another meaning, that reorganization is the process of *reasoning* As one may note in passing, that is exactly the sort of experience critics refer to as the flash of creative imagination, in their balmier moods they call it inspiration

In addition to distinguishing between directed organization, which is understanding, and a new configuration with the elements thrown into another order and relation by a new insight, which is reasoning, there is a third feature of the whole process that is vital for us here — the point in time to which the experience is referred in consciousness Three facts, let us say, are clearly perceived though isolated experiences, a fourth is added and the mind "clicks." The three and one become on the instant not four separate entities but an integrated whole The moment when this organization takes place may appear in consciousness associated in point of time with any of the three isolated experiences that preceded the incidence of the integrating fourth The one of the three upon which attention was most definitely fixed as a separate experience, or which has in other ways closest lines of connection with the fourth, will be the point in the temporal series where the newly organized unity will be oriented

To the reader capable of believing that Emilia from the first suspected the villainy of Iago, it is quite enough to say that we have

<sup>1</sup> Koffka, Kurt, *Principles of Gestalt Psychology* (1935), pp 591-647; Mauer, Norman R. F., "Reasoning in Humans," *Journal of Comparative Psychology*, 12 (1931) 181-194.

the lady's word for it. We do have her word for it, and under circumstances in which even such a woman as Mrs Jameson thinks her to be might tell the truth. That is precisely the point. She thinks she thought so then. All there is to psychology is seen in just that — the explanation of how a complex matter is mistaken for a simple one.

To examine *what* she thought and *when* it will be enough for our present purpose to break down each of these into four parts. For the question of *when* we may select four incidents that ought to have fixed her attention sufficiently to lead to an interpretation. First there is the giving of the handkerchief to Iago in Act III. Then there is the rather violent scene where Othello demands the handkerchief and the lady "of unblemished truth" lies about it rather awkwardly. Othello plies Emilia with questions about Desdemona, and she suspects there is villainy afoot, but she does not then follow up the idea. Then when Desdemona describes Othello's rage, she takes up again her suspicion of some whispering villain and gets it quite clear in her mind that some mischief-maker is at work and what the motive is. There are four rather definite incidents that in retrospect might well have a meaning. Why they did not have, has a better explanation than Emilia's stupidity or her inherent brutality. To any of these four she might conceivably have reference when she says she "thought so then." It should be noted in passing that the first two have definite reference to the handkerchief and the last two have equally definite reference to Othello's suspicion and to Emilia's explanation for it. Under what circumstances would any particular one of these four become the focal point in past experience to fix the time to which this new meaning throws back?

The question of *what* she thinks becomes a question of what detail of suggestion would serve to shift previously unrelated incidents into a relationship to give a unity and a meaning. Here again we may for convenience mark off four stages of perception, at each of which she manages to get a measurably clear notion of certain things belonging together to give a certain meaning. These four all occur in the last scene of Act V and within a compass of forty-four or, at most, fifty-seven lines; in time of action it would cover perhaps ten minutes. She thinks only when she has to. That is normal behavior. The first of these four stages of perception is at the point where Othello finally makes her understand that he is charging

Desdemona upon the word of Iago (lines 138-158) The second stage in a growing comprehension is seen where she appeals to Iago to deny Othello's charge The third in the cumulative series is the crucial one, where she sees that Iago is in fact the villain The fourth stage and the climax of the series is that in which Cassio's name furnishes the motive of Iago and ties it in exactly with her earlier conviction that it is being done to get some office (IV ii 132)

At the moment of the discovery of the murder the thought processes of Emilia become as definitely directed and channeled as if it were a laboratory exercise to demonstrate how the thinking may be made to take and hold a certain predetermined course When last she talked with Othello of Desdemona's fidelity she hit on the idea that he was being imposed upon by some talebearer, the idea had become fully developed in the subsequent discussion of the same point with Desdemona and Iago, and an adequate motive for it had been supplied That this would be the starting place of her thinking in the present crisis is about as inevitable as anything in this life could well be The idea had first appeared as a hypothesis, "If any wretch have put this in your head " But later, in the presence of Desdemona and Iago, there is no "if" about it With that bent and direction she begins now to put things together So foreign to all her past thinking is the idea that her husband would be even suspected of such villainy that only reiteration finally convinces her that he is being accused of it by Othello She has not the slightest doubt but that Iago will prove he did no such thing When the villain was just "some eternal villain" her interest in it was only in the depth of the villainy She could say with genuine cordiality, ". . . hell gnaw his bones!" Then she is confounded to see that Iago has been the villain "You told a lie, an odious, damned lie"; and then is added another element. "Cassio! Did you say with Cassio?" There is the motive — to get some office

By that definite series of additions she has built up the conviction that all this is the work of her husband. She is so stunned by the conviction and so overwhelmed by emotion that she can do nothing for the moment but review the whole series of facts

Villainy, villainy, villainy!  
I think upon't; I think I smell't; O villainy!  
I thought so then. I'll kill myself for grief  
O villainy, villainy!

That this whole series constitutes one completely unified whole, tied together without, for the moment, any loose ends is seen in the contrasting calmness and composure of her next speech "Perchance, Iago, I will ne'er go home" Her whole attention has been centered upon this wretched villainy, the motive of the infamous scandal-monger, and at last the identity of the scoundrel *What* she thought and *when* can be placed with accuracy within the limits of time and circumstances upon which, in the emergency, she bases her thinking through to an understanding

The relatively calm and assured manner of "Perchance, Iago, I will ne'er go home," gives something near a perfect rounding off and completion of that part of the action She now believes she sees just how matters stand Her thinking is freed from the directed and channeled course the absorption in the problem of the villain had made inevitable Then when Othello goes into detail by introducing the evidence of the handkerchief, she is completely bowled over The crushing blow is all the harder for her momentary calm in understanding, conviction, and, as we have seen, a consequent resolution With the handkerchief comes an instant and complete reinterpretation It is, of course, the most overwhelming moment in her life because the one thing that ties together the whole sinister plot is the one for which she has been herself unwittingly responsible It is eminently right that at such a moment she has at her command only the exclamation "O God! O heavenly God!"

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## THE LOVE OF SIR PHILIP SIDNEY FOR THE COUNTESS OF PEMBROKE

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THE initial purpose of this paper was consideration of evidence presented by Dr Ralph M Sargent in his life of Sir Edward Dyer, *At the Court of Queen Elizabeth*, published in 1935,<sup>1</sup> for a love rivalry between Dyer and Sir Philip Sidney with Sidney's sister, the Countess of Pembroke, as its object Pursuit of that aim has led to an article in three divisions, the second and third of which, while interlocked with the first, are also of independent interest First I shall analyze Dr Sargent's argument, secondly, I shall offer identifications alternative to those of Dr Sargent — the pivot of his argument — for the characters in Dyer's poem *Amarillis* and in the passage in the original version of Sidney's *Arcadia* in which Philisides voices a love lament for Mira; in conclusion, I shall examine the character and the reliability of that peculiar body of material in John Aubrey's writings which was brought to light in 1931 by John Collier under the title *The Scandals and Credulities of John Aubrey*,<sup>2</sup> and which appears to have suggested Dr Sargent's hypothesis

The figures of many illustrious Elizabethans never quite emerge from a cloudy background of rumored strange crimes and intrigues Sir Philip Sidney and his sister, Lady Mary, Countess of Pembroke, have seemed by contrast to stand in a clear light. The imputation of incest must come as something of a shock to careful students of the sixteenth century as well as to those whose view is more colored by idealization and romanticizing of the memory of Sir Philip John Aubrey, in his *Brief Lives*, wrote that he had "heard old gentlemen say that they lay together" The passage remained generally unknown, because suppressed by Andrew Clark in his edition of 1898,

<sup>1</sup> *At the Court of Queen Elizabeth The Life and Lyrics of Sir Edward Dyer* (London and New York Oxford University Press)

<sup>2</sup> London Peter Davies (Shenval Press), and New York Appleton My references are to the New York edition, Dr Sargent's reference is to the London edition, with different pagination.



until brought to attention by Mr Collier's publication. One of Aubrey's characteristic incongruities, without corroborative evidence, would not in itself be occasion for extended comment, but when a modern scholar offers Aubrey's statement in conjunction with what appears to him to be supporting evidence the charge should be closely examined. Dr Sargent's evidence, presented on pages 66-70 of *At the Court of Queen Elizabeth*, depends upon the interpretation of Dyer's *Amarillis* and the Philisides-Mira passage in the *Arcadia*, with certain details pointing to identification of Lady Mary with *Amarillis* and Mira.

Dr Sargent does not commit himself so far as Aubrey's charge, of which he says "The charge need not be taken too seriously, it is probably only a rash inference from the passionate devotion Sidney was known to cherish for his sister," and he concludes "one still cannot infer that Dyer and Sidney had become involved to the extent of illicit hopes." He does, however, make out a case for an illicit passion, that is, the potentiality for illicit hopes and acts. For the latter he finds no evidence beyond Aubrey's unsupported assertion, which, apparently, like most of us, in the light of the characters of Lady Mary and Sir Philip as generally understood, he prefers not to accept. Such being the case, an alternative interpretation of the passage in the *Arcadia* and Dyer's poem which removes the occasion of doubt may be welcomed.

# I

The first step in Dr Sargent's argument is the identification of Coridon, the obscure friend of Philisides in the *Arcadia*, with Edward Dyer (Philisides, of course, is generally accepted as Philip Sidney). The evidence, if not conclusive, is convincing.<sup>1</sup> Dr Sargent then

<sup>1</sup> The best argument for the identification is the conjunction of the statement in Sidney's poem, "old Lanquet . . . To worthy Coriden he gave me ore," with Lanquet's reference to Edward Dyer in his letters to Sidney, of which Dr Sargent quotes the most conclusive example.

There is some confusion in spelling which must be noted in order to explain variations which will appear in this paper. Dr Sargent states that the name "Coridon" in the printed versions was "Coridens" in the original version. The reference is to Feuillerat's edition of the *Arcadia*, Original Version, where the name is "Coredens." See pp 229, 238, 318. The *e* for *i* mars Dr Sargent's interpretation of the name as an anagram for "Cosin Dier." On the other hand, Dr Sargent quotes the spelling "Coridon" from Feuillerat's edition of the 1593 folio (p 75), where the spelling is actually "Coriden." The spelling is also

applies the identification of Coredens with Dyer to the mention of Coredens in a speech by Philsides in the Fourth Eclogue of the original version, in which Philsides ascribes his melancholy and retirement to rejected love for the "sweet and incomparable" Mira, who had also been the object of Coredens' "despayring desyers" <sup>14</sup>

Dr Sargent points out the parallelism between this story and that of Dyer's *Amarillis*, one of the two extant poems in which Dyer adopts a pseudonym, "Coridon" in each instance "The . . . poem relates how Coridon and his best friend, Caramell, fell in love with Amarillis, how the rivalry produced an unhappy rift between the two men, and how, in the end, neither one succeeded in winning the lady's love entirely for himself" He continues "Now Dyer takes pains to point out that his *Amarillis* refers to actual incidents The penultimate couplet reads

Well I wott what here is ment, and though  
a talle it seme,  
Shadowes have ther bodies by, and so of  
this esteeme

Upon analysis of the poem Dr Sargent concludes "After allowing for all the fictionizing of poetic art, one can scarcely doubt that here is disclosed some sort of a love-triangle in which Sidney and Dyer had become involved"

The next problem for Dr Sargent is to identify the lady styled "Amarillis" by Dyer and "Mira" by Sidney For reasons which I shall discuss later he would almost, although not quite, exclude the possibility of Queen Elizabeth, he also rejects Penelope Devereux

I shall now consider the successive steps in Dr Sargent's argument for connecting "Mira-Amarillis" with Philip Sidney's sister

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"Coriden" in the same context (Philsides' song of his past life, in which he says, "old Lanquet To worthy Coriden he gave me ore") in Feuillerat's edition of the 1590 quarto (p 133) In another context, in which less attention would be drawn to the possibility of an anagram, the spelling "Coridon" appears in the 1593 folio (Feuillerat, p 62) "Coridon" does not appear in the Lanquet passage until the sixth printing of the folio, in 1613 As Feuillerat's edition of the original version of the *Arcadia* is a reprint of the Clifford MS, one of five copies still in existence, the spelling "Coriden" in both the 1590 and the 1593 printed versions suggests that *e* instead of *i* may be an inaccuracy of the Clifford MS — which would bring us back to Dr. Sargent's anagram

<sup>14</sup> *The Complete Works of Sir Philip Sidney*, ed Albert Feuillerat (London Cambridge University Press, 1922-26), IV 318. Hereafter cited as *Works*

1. "Obviously 'Mira' is simply an anagram for 'Mary' — an appellation common enough to leave room for plenty of futile speculation. Nevertheless, it is impossible to overlook the fact that it is the name of Philip's own sister."

"Mira" may be an anagram for "Mary," but just as obviously means "wonderful," and is a complimentary name like *Coelia* and *Gloriana*, as such the name is especially appropriate to Queen Elizabeth.

2. "The uncommon strength of Sidney's affection for his sister has frequently been observed. 'Most dear, and most worthy to be the most dear Lady,' he addresses her in the dedication to the *Arcadia*, 'Your desire, to my heart, is an absolute commaundment.' And he concludes by praying that 'you will continue to love the writer, who doth exceedingly love you.'" (The tone of Sidney's address to his sister is conveyed more accurately if the last sentence is completed "and most hartely praies you may long live, to be a principall ornament to the familie of the Sidneys.") Farther on Dr Sargent refers to "the passionate devotion Sidney was known to cherish for his sister."

The tradition of Sidney's devotion to his sister has been built upon the dedication to the *Arcadia*, which has, heretofore, suggested no more than a normal and beautiful affection of an elder brother for an only sister. Philip was twenty-six in 1580, Mary nineteen. The Sidneys were a notably harmonious and loving family, and the circumstances that Philip's two brothers were even younger than Mary and that three sisters between Philip and Mary had died in infancy or early girlhood may have accentuated the affection.<sup>5</sup>

3. "Little is known about Dyer's relation to women, except that he wrote frequently on the subject of love, yet never married. Here again, Aubrey has something to say. He takes pains to point out that Dyer was an especial friend of the Countess of Pembroke; he even implies that Dyer was more intimate with her than with her brother."

I do not see any possible implication in Aubrey's statement that Dyer was more intimate with the Countess of Pembroke than with her brother. He simply writes "Sir Edward Dyer . . . was a great witt, poet, and acquaintance of Mary, Countesse of Pembroke, and Sir Philip Sidney. He is mentioned in the preface of the 'Ar-

<sup>5</sup> Young, Frances Berkeley, *Mary Sidney, Countess of Pembroke* (London, 1912), p. 9.

cadia' " \* As a matter of fact, Dyer is not mentioned in a preface, or elsewhere, in any edition of the *Arcadia* to the time of Aubrey's writing the *Brief Lives*, unless it is in the 1590 quarto, which I have not examined. Professor Feuillerat's editing of the quarto can be relied on, however, and shows no mention of Dyer.

4 Dr Sargent points out that Dyer, as a close friend of the Sidneys, "certainly possessed ample opportunity for exposure to Mary's charms," which is true enough, but the progression to "Who more fitting to inspire Dyer's *Amarillis* than she whom a later poet immortalized as 'the subject of all verse'?" is surely questionable. The Countess had, of course, been a liberal patroness of letters for a good many years when immortalized by the later poet.

5 Dr Sargent justly mentions that the morals of the age were less narrow than those of three hundred years later. Without considerable evidence, however, I should not be prepared to accept this latitude as extending to incest. There was certainly breadth of attitude toward amours in general, largely as a result of the marriage of convenience as an established custom. Possibly because brothers and sisters in aristocratic families so frequently grew up apart from each other, incest, it is true, appears to have been more common in the sixteenth century than today, but not more condoned. Even at the morally relaxed court of King James I ' the Star Chamber case of Sir Thomas Lake, Lady Lake, Lady Ross, and the Countess of Exeter was the most notorious scandal of years, particularly so because incest was involved. Lady Anne Clifford wrote in her *Diary* for February, 1619 "There was nothing heard all this term but the matter between the Countess of Exeter and them [Sir Thomas Lake, his Lady, and Lady Ross] there was spoken extraordinary foul matters of my Lady Ross and reports went that amongst others she lay with her own brother, so as their foul matters did double the miseries of my Lady Lettice Lake in her unfortunate marriage " "

\* Dr. Sargent's reference is John Aubrey, *Brief Lives*, ed. Clark (1898), I 248.

<sup>1</sup> Evidence of the change is ever present in contemporary documents, e.g. Sir John Harington's description of the debauchery at the entertainment of the Danish king and his unfavorable comparison to the days of Elizabeth. See *Nugae Antiquae* (London, 1779), II: 126-131. Harington was a broadminded man. See also *The Diary of the Lady Anne Clifford*, ed. V. Sackville West (New York, 1923), pp. 16-17. "There was much talk how all the Ladies about the Court had gotten such ill names it was grown a scandalous place "

<sup>2</sup> *Op. cit.*, pp. 87-88.

The Lady Ross was also generally execrated for her defamation of the character of the Countess of Exeter in which the charge of incest was prominent.<sup>9</sup>

6 Dr Sargent's conclusions, as has been stated, are tentative. Assuming Mary Sidney to be the lady referred to and granting the difference in morals, "one still cannot infer that Dyer and Sidney had become involved to the extent of illicit hopes. Any poet puts on paper more than he would commit himself to in conduct." Near the beginning of his discussion Dr Sargent states "The Countess of Pembroke and the privileged friends who read the manuscripts of the original *Arcadia* would easily grasp the allusion of this passage [the "Mira" passage noted on p 586]. Significantly, perhaps, this whole passage was excised from the printed version."

Under the circumstances of composition of the original version of the *Arcadia* the only motive for introducing more or less disguised real persons and events was the sport of recognition by the intimate circle of listeners or readers. Sidney would never have included a passage suggesting even inclination of an incestuous kind toward the lady to whom the book was addressed. Exaggeration and scandal were normally alert in the sixteenth century. The excision of the passage in the printed version is without editorial significance, since in his revision of the *Arcadia*<sup>10</sup> Sidney had removed from the eclogues to new contexts the two songs which the passage serves to link. The revelation of incestuous inclination, in any case, would have been as undesirable within the intimate circle as before the public.

## II

Without the influence of Aubrey's statement it appears to me that Dr Sargent might very well have arrived at a more plausible and consistently applicable interpretation of the Mira and Amarillis stories. Mira and Amarillis are Queen Elizabeth, and Charimell<sup>11</sup> is Christopher Hatton instead of Philip Sidney. Nearly all the evi-

<sup>9</sup> For especially pertinent comment see the letters of John Chamberlain and others collected in *The Court and Times of James the First*, ed. Robert Folkestone Williams (London, 1848), II. 68-69, 70-71, 175-177. John Chamberlain was a liberal man of the world.

<sup>10</sup> *Works*, I. 357, 394.

<sup>11</sup> Dr Sargent writes "Caramell" in his own text and prints the name as "Charimell" in the poem.

dence necessary for the interpretation of Dyer's poem can be drawn from facts and sources cited in Dr Sargent's book

Dr Sargent's arguments against identification with Queen Elizabeth are as follows "when Dyer explains that his *Amarillis* is in the service of Diana, he implies that she is a lady-in-waiting, rather than the queen herself", and "Sidney's tone toward his Mira, with its ring of easy familiarity, also appears to preclude the identification with the queen" The poetic treatment of Elizabeth was not so restricted She was commonly figured either as Diana or as a nymph or shepherdess devoted to Diana, with the pastoral mode, as in the *Arcadia* and in *Amarillis*, lending itself more readily to the humbler guise In Spenser's April Eclogue Elizabeth is "fayre Eliza, queene of shepheardes all", in Henry Chettle's *England's Mourning Garment* she is "that sacred Nymph, that careful Shepheardesse Eliza", in George Peele's semipastoral drama *The Arraignment of Paris* she is "a gracious nymph, That honour[s] Dian for her chastity" In Sidney's *Arcadia* Mira is a nymph of Diana's,<sup>12</sup> and Dyer's *Amarillis* "To Diana at her burth hur parents did hur geve"<sup>13</sup> Sidney's familiarity of tone is in part that of the pastoral mode, as manifested in the form "Eliza" for Elizabeth in other pastorals, in part that of a gentleman writing at his pleasure for an intimate circle of friends and not for Elizabeth's eye or favor

The plots of the Mira poem and *The Arraignment of Paris* are significantly parallel In Peele's drama Juno and Pallas complain of the award of the famous apple by Paris to Venus The three goddesses submit the judgment to Diana, who decrees the golden ball belongs to the fair Eliza,

In state Queen Juno's peer, for power in arms  
And virtues of the mind Minerva's mate  
As fair and lovely as the Queen of Love,  
As chaste as Dian in her chaste desires

In Sidney's poem Venus and Diana dispute the supremacy and submit their quarrel to the lad Philusides He appoints the nymph Mira above them both This combination in one woman of chastity with all the charms that incite to love is exactly appropriate to conventional praise of Elizabeth One line in *Amarillis*,

He had found that *amarillis* sought glorie more than love,

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<sup>12</sup> *Works*, IV 315

<sup>13</sup> Sargent, *op cit*, p. 192

strongly suggests the Queen, and is reminiscent of a passage in Dyer's letter of advice to Hatton when Hatton feared the Earl of Oxford was usurping his place with the Queen "First of all you must consider with whom you have to deale, & what wee be towards her, who though she does descend very much in her Sex as a woman, yet wee may not forgett her Place, & the nature of it as our Sovraigne" <sup>14</sup>

Although Dr. Sargent presents the Mira and Amarillis stories as closely parallel, the resemblances are slight. Charimell and Coridon, fast friends, were smitten together with love of Amarillis, such rivalry developed that their friendship was forgotten in fruitless pursuit of Amarillis' favor. Both lovers pined and died of despair. By Amarillis' supplication to Diana both lovers were metamorphosed, Coridon to an owl that fled to the wilderness, but Charimell to a yellow flower which Amarillis plucked, and "wore it on hur hedd, Somtyme she layd it on hur lap, and somtyme on hur bed." Evidently Amarillis cared more for Charimell. Sometimes, however, she would repair to the wood and delight to hear "the lay and tune" of Coridon's despair.

In Philsides' story <sup>15</sup> Coredens had loved Mira before Philsides saw her. "To her I say, whome even Coredens had made the upshoote of all his despayring desyers." There is no mention of any rift in friendship. The rest of the passage is an apt description of the course of Sidney's relations with Elizabeth to 1580, the time of writing. "and so alas from all other exercyses of my mynde bent my self onely to the pursuite of her favour, But having spent some parte of my youthe in followyng her, some tymes with some measure of favoure sometymes with unkynde Interpretacyons of my moste kynde thoughtes. In the ende haveinge attempted all meanes to establish my blisfull estate, & having bene not onely refused of all Comfort, but new quarrells picked agenst mee, I did resolve by perpetuall absence to choke my owne evill fortunes." After signal successes and favors and numerous disappointments and checks in Elizabeth's service, Sidney felt so rebuffed by the Queen's reception of his letter opposing the French marriage that, late in 1579, he withdrew from court to Wilton, a retirement which lasted approximately a year <sup>16</sup>. The reference to Coredens is exactly applicable to

<sup>14</sup> Sargent, *op cit*, p. 24

<sup>15</sup> Works, IV. 318

<sup>16</sup> *Correspondence of Sidney and Langest*, trans. Steuart A. Pears (London, 1845), pp. 184, 185, 187

the relation of Dyer to Elizabeth at the beginning of Sidney's courtiership in 1575 Dyer had entered upon courtiership nine years earlier, but in 1575 had been out of favor for the past four years<sup>17</sup>

Before Mira is mentioned by name in the original version of the *Arcadia* Philsides has appeared frequently in the eclogues; the fact that he is a stranger in Arcadia is reiterated, he is always melancholy, and his mind seems to be elsewhere than at the festivities<sup>18</sup> These details are all so suitable to Sidney's situation at Wilton in 1580 that the introduction of Mira as the object of his contemplation and cause of his woes, and the statement, "I did resolve by perpetual absence to choke my owne evill fortunes," could hardly have failed to suggest the Queen to the Wilton circle Mira would not fit the Countess of Pembroke, since Sidney was not absent from her

Mira has, of course, been traditionally identified with Penelope Devereux as well as with Queen Elizabeth The arguments for Penelope have been most recently and fully presented by Miss Mona Wilson in her introduction to *Astrophel and Stella* (1931) and in her life of Sidney (1931) The identification does not appear to me impossible, but when the year of writing, 1580, is considered, identification with Queen Elizabeth seems considerably more apt Sonnet 33 marks the marriage of Penelope, which did not take place until late in 1581 There is nothing in the first thirty-two sonnets to fit Philsides' resolve on perpetual absence Penelope Devereux was intimate with the Sidneys in the lifetime of her father, and she was even more closely associated with the Sidneys by her mother's marriage to the Earl of Leicester in 1577 It is improbable that she was not at times among the ladies present at Wilton whom Sidney so frequently addresses in the original version of the *Arcadia* In his unfinished revision of the *Arcadia* Sidney dissociated Mira and Philsides, omitting the prose passage and giving to Amphialus the song containing her name, in a new passage (*Works*, I 285) he unmistakably introduced the Stella of the sonnets as the object of Philsides' devotion, at a jousting, among the ladies at the windows "there was one (they say) that was the *Star*, wherby his course was only directed" The assignment of a song addressed to Mira (which does not appear in the original version) to Philsides in the 1593 folio (*Works*, II 70) is inconsistent with the revision, and is evi-

<sup>17</sup> Sargent, *op cit*, pp 18-19, 23, 29

<sup>18</sup> *Works*, IV. 67, 119, 151, 229, 237, 306, 312



dently an editorial allocation of one of the loose songs left by Sidney. By the time of the revision the sonnet sequence, and perhaps actual relations between Sidney and Lady Penelope Rich, had developed in such a manner as to fit the relation of Philsides to his mistress, in 1580 the woes of Philsides are more adequately explained by the displeasure of Elizabeth.

According to Dr Sargent, Dyer as well as Sidney withdrew from court activities for a while in 1580, owing to the involvement of the whole Leicestrian faction in the Queen's displeasure at interference in the Alençon marriage negotiations.<sup>19</sup> In the only other mention of Coredens besides those of the *Languet* and the *Mira* contexts he is associated with Philsides as a melancholy stranger in *Arcadia*. "Thether [to the pastoral festivities of the Third Eclogue] came of Straungers Shepheardes, onely the Melancholy Philsides, for the vertuous Coredens had longe synce lefte all joyfull solempnities"<sup>20</sup>

As the story of Philsides, Coredens, and *Mira* corresponds to certain relations of Sidney and Dyer to Queen Elizabeth, so that of *Coridon*, *Charimell*, and *Amarillis* corresponds to certain relations of Dyer and Christopher Hatton to Elizabeth. Hatton and Dyer were two ambitious young men entering upon courtiership at nearly the same age and at nearly the same time.<sup>21</sup> The letter from Dyer to Hatton, quoted by Dr Sargent on pages 24-26, shows them to have been friends in October, 1572, the letter from Gilbert Talbot to his father, the Earl of Shrewsbury, quoted on page 28, shows them to have been rivals for Elizabeth's favor in May, 1573.<sup>22</sup> Hatton had for two years been disturbed over the attentions shown by Elizabeth to a new favorite, the Earl of Oxford, Dyer had been definitely under the Queen's displeasure for two years. Hatton became seriously ill and Elizabeth rushed to his side, visited him daily (here I supplement Dr. Sargent from Gilbert Talbot), and on his recovery restored him to higher favor than ever. Dyer, falling ill, had the report given out that his illness was because of the Queen's continued displeasure toward him, and that he would never recover.

<sup>19</sup> Sargent, *op cit*, p 55      <sup>20</sup> *Works*, IV 229      <sup>21</sup> Sargent, *op cit*, p 24.

<sup>22</sup> Part of a sentence omitted by Dr Sargent emphasizes the rivalry. Dr. Sargent quotes as follows "Now in their devices . . . how to make Mr Edward Dier as great as ever was Hatton." Gilbert's letter continues, "for now, in this time of Hatton's sickness, the time is convenient." Edmund Lodge, *Illustrations of British History, Biography, and Manners* . (London, 1839), II. 18

unless she would forgive him. The Queen forgave him and sent him a "very comfortable message," but after his recovery took little notice of him.<sup>22</sup>

During part of the period of absence of royal favor Dyer retired to Woodstock Manor, of which he held the stewardship.<sup>24</sup> In the summer of 1575 the Queen took in Woodstock on a progress. Dyer seized the opportunity for a bid for return to favor. After the day's festivities, in which he did not appear but arranged to remind Elizabeth dramatically of himself in the shows presented, as she was passing in her coach "closlie in an Oke she hearde the sound both of voice and instrument of the excellentest now living whose pleasantnesse ther in bred a great liking." The minstrel was Dyer, and the song was his lament known as *The Song in the Oak*. When the song was concluded, "Now was it darke nighte, and her Majestie filled with conceites, returneth home." Dyer's effort was favorably received, although without tangible reward until the following January.<sup>25</sup>

The events recounted above fit *Amarillis* exactly. Charimell's hopes continued longer than did those of Coridon, and it was Charimell's death, not Coridon's, that sent *Amarillis* to Diana praying that "those two to lovinge thinges be transformed anewe." *Amarillis* plucked the yellow flower that was Charimell and "wore it on hur hedd, Sometye she layd it on hur lap, and sometye on hur bed." Hatton was restored to high, and intimate, favor. Dyer, living in seclusion at Woodstock and uttering his lament to Elizabeth from the oak as night falls, is pictured in the owl fled to the wilderness, avoiding company and the light of day, but with *Amarillis* at some time repairing to the wood and delighting to hear "the lay and tune of his dispare."

Dr Sargent believes that at least four of Dyer's laments — he does not designate which — besides *The Song in the Oak* seem "particularly to refer to his period of disfavor from 1572 to 1575."<sup>26</sup> Two of the poems have connections with *Amarillis*.<sup>27</sup> *Alas, My Heart*,

<sup>22</sup> Sargent, *op cit*, pp 24, 27, 28, 29.

<sup>24</sup> *Ibid*, p 27

<sup>25</sup> *Ibid*, pp 29-35. The quotations are from a pamphlet of 1585 describing the festivities at Woodstock, the authorship of which is unknown to Dr Sargent.

<sup>26</sup> *Ibid*, p 166

<sup>27</sup> The fourteen poems accepted by Dr Sargent as Dyer's are printed in his volume, pp 175-201. Since Dr Sargent's publication three new poems by Dyer have been discovered and published. Bernard M. Wagner, "New Poems by

the one other poem in which Dyer adopts a pseudonym, "Cordon," is particularly apt in its terms for address to Queen Elizabeth. *A Fancy*, the one other poem besides *Amarillis* which Dyer tags with a statement that there are real events under the poetic guise, has also some points of contact with *Amarillis* in content. Although there is no metamorphosis, the author of *A Fancy* retires in his despair to "solitarie woodes," "whereto noe light shall come," and mentions the owl, "the scritchinge owle my clock." These details suggest Woodstock, and that *A Fancy* has to do with Elizabeth is indicated by the association of fortune with love in his mistress' former favor to him.

Whome love and fortune once advaunced and now  
hath cast away

Some additional minute parallels between *Amarillis* and the relations of Hatton and Dyer to Elizabeth as presented by Dr. Sargent in his second and third chapters could be pointed out, but what has been outlined seems to me sufficient to establish connection between the conclusion of *Amarillis* and the *Song in the Oak* episode. *Amarillis* might have been written earlier during Dyer's retirement at Woodstock, and the conceit in the poem have suggested the device for gaining Elizabeth's attention, but it seems more likely that *Amarillis* records the event of September, 1575, and was written within the next few months, when Dyer knew his plea had been favorably received but was uncertain how far the new-found grace would go.

### III

So generally has the epithet "unreliable" been coupled with the name of John Aubrey in recent years that many scholars have probably dismissed the passages restored by Collier as casually as does Dr. Marcus Selden Goldman with a footnote in *Sir Philip Sidney and the Arcadia*: "The morbid psychologists will find much delight in the pages devoted to Sir Philip and the Countess of Pembroke, but it is probable that other people will count them mere credulities of Aubrey, who was always particularly credulous when there was a question of evil among the Herberts or their allies."<sup>18</sup> The appear-

Sur Edward Dyer," *The Review of English Studies*, II (1935) : 466-471. I do not find anything in the new poems that bears on the present problem.

<sup>18</sup> *University of Illinois Studies in Language and Literature*, XVII (Nos. 1-2, 1934) 117.

ance of influence, even without complete acceptance, on so careful and objective a work as that of Dr. Sargent, in which there is certainly no suggestion of the "morbid psychologist," seems, however, to call for a few observations on the reliability of the "scandals" in particular.

No one now considers seriously the statement of Aubrey's biographer, John Britton "The care taken to ensure accuracy in his statements, and to record the names of his informants, in all cases where he does not speak from his own knowledge, stamp them with a high degree of authenticity" <sup>29</sup> A typical citation of authority by Aubrey, in this instance for an extremely improbable but not wholly incongruous story of Sir Thomas More and Sir William Roper, runs "This account I had from my honoured friend old Mr<sup>td</sup> Tyndale, whose grandfather, Sir William Stafford, was an intimate friend of this Sir W Roper, who told him the story" <sup>30</sup> The best comment on such a historical method may be derived from another story by Aubrey "He [Thomas Chaloner] had a trick sometimes to goe into Westminster Hall in a morning in Terme time, and tell some strange story (sham), and would come thither again about 11 to 12 to have the pleasure to heare how it spread and sometimes it would be altered, with additions, he could scarce know it to be his owne" <sup>31</sup> Mr Collier, in his lively introduction, ascribes the confused state of Aubrey's hiatus-filled manuscripts to the familiar circumstances of his residence with Edmund Wyld and other patrons He was kept up to all hours at drinking debauches, which interfered sadly with his labors the following day Some of Clark's excisions seem to a modern reader very, very delicate-minded, but a considerable number of the passages restored by Mr Collier might well be aftermaths of Edmund Wyld's drinking bouts. They are at best the kind of stories that men like to pass around the table after the ladies have retired Whatever Aubrey heard he set down No one would, I am sure, suggest that the bawdy story of Sir Walter Raleigh on page 42 was true; it is clearly just a story, without any suggestion, without the possibility, of authentication But there is little more actual authentication offered for the scandals concerning Philip Sidney and the Countess of Pembroke.

<sup>29</sup> *Memoir of John Aubrey* (London, 1845), p 109

<sup>30</sup> *Scandals and Credulities*, p 2

<sup>31</sup> *Ibid.*, p. 106.

Ground for dismissing these scandals is not to be found, however, in Clark's statement in the Preface to *Brief Lives*, repeated by Dr Goldman, that "Aubrey is generally nasty when he mentions the noble family of Herbert, earl of Pembroke, and the allied family of Sydney. There may be a personal pique in this, for Aubrey thinks he had a narrow escape from assassination by a Herbert (i 48)." Such an incident occurred, but Aubrey evidently bore no family grudge — he was anything but a vindictive man. In Chapters II, III, and IV of Part II of the *Natural History of Wiltshire*<sup>32</sup> Aubrey presents the Pembrokes as the glory of his county, and in juxtaposition to the "slanderous" passages in the accounts of Philip Sidney and the Countess of Pembroke in the *Lives* he eulogizes them above almost any other of his subjects. Furthermore, he records things just as bad about people other than the Pembrokes and their allies. I am convinced, with Mr Collier, that Aubrey had a mind that was innocent<sup>33</sup> — but also salacious. I do not think that John Aubrey was conscious of injuring the reputations of his subjects, he simply had no sense of discrimination, either for morals or for facts.

Mr Collier makes no claim for the factual reliability of Aubrey's scandals. He writes "This edition is intended to throw an abrupt and violent light upon that element in Aubrey which is least dependent on verifiable facts."<sup>34</sup> Part of his purpose was to restore John Aubrey the man and his milieu. "His portrait, therefore, is to be found on every page of this book" and "such was the seventeenth century."<sup>35</sup> Mr Collier greatly exaggerates, however, the element of essential if not factual truth to the subjects to be found in Aubrey's unseemly stories and comments. To make his point he cites "Ben Jonson had one eye lower than t'other, and bigger, like Clun the player. Perhaps he begott Clun," and comments "The important point is, do you see, not whether or no Jonson was actually guilty of this superfluity, but that we are at once convinced that he was capable of it, and this because it is so apparent that Aubrey's speculative interest is none of those baser interests which might have tempted him to distort."<sup>36</sup>

That this reference to Jonson has the look of a *jeu d'esprit* is undeniable, but Mr Collier has picked the best of the lot. The happy

<sup>32</sup> Ed John Britton (London, 1847).

<sup>33</sup> *Ibid*, p xvi

<sup>34</sup> *Ibid*, pp. xxi, li

<sup>35</sup> *Op cit*, Intro, p xx

<sup>36</sup> *Ibid*, pp xviii-xx.

touch is rare, and is offset by such ugly incongruities as what Aubrey "heard old gentlemen say" and what "was thought" of Philip Sidney and the Countess of Pembroke (that "the first Philip earle of Pembroke was begot by him, but he inherited not the witt of either brother or sister") The same process of association that is revealed in Aubrey's random shot concerning Ben Jonson and Clun, operating in minds like his own, will explain the origin of the stories he so readily recorded Philip Sidney dearly loved his sister and was much at Wilton, perhaps he lay with her Someone remarked, from the association of names, and thinking loosely of family resemblance, not of direct descent, that Philip Herbert inherited not the wit of his mother nor of his uncle Philip, shortly, Philip Herbert was begot by his mother's brother

More gross in the mental functioning, although less slanderous, and even more obviously incongruous with essential truth as well as certainly contrary to factual truth, is Aubrey's account of Sidney's death

He married the daughter of Sir Francis Walsingham, whom he loved very well

Having received some shott or wound in the warres in the Lowe-Countreys —, he would not (contrary to the injunction of his physitiens and chirurgions) forbear his carnall knowledge of her, which cost him his life, upon which occasion there were some roughish verses made "

As a matter of Aubrey's historical methods, it might be noted that his account is presented bluntly as fact and without mention of any authority, unless the "roughish verses" be considered such The physical impossibility as well as the personal incongruity of the story are so manifest from numerous and familiar firsthand and minute accounts of Sidney's wound, period of illness, and last hours that detailed comment is unnecessary " Fulke Greville's *Life of Sir*

" *Scandals and Credulities*, p 10

" See Malcolm W Wallace, *Life of Sir Philip Sidney* (Cambridge University Press, 1915), pp 380-388, for a reliable summary and numerous excerpts from a variety of first sources, Fulke Greville, *Life of Sir Philip Sidney*, ed Nowell Smith (Oxford Clarendon Press, 1907), pp 129-140, for a full source account Consider especially Leicester's letter to Burghley (Wallace, p 381) "a musket shot upon his thigh three fingers above his knee, the bone being broken in pieces", and Greville (p 133) "Now after the sixteenth day was past, and the very shoulder-bones worn through the skin, with constant, and obedient, posturing of his body to their Art" From the continuation of Greville's account it is apparent that blood poisoning had set in and was the cause of death

*Philip Sidney* was published in 1652 and was available to Aubrey. Although free from malice, Aubrey in his selection of material was evidently moved by one of the "baser interests" which tempt to distort.

Two of the suppressed passages concerning Philip Sidney or the Countess of Pembroke have now been discussed. One remains Aubrey wrote of the Countess of Pembroke. "She was very salacious, and she had a Contrivance that in the spring of the yeare when the stallions were to leape the mares, they were to be brought before such a part of the house, where she had a vidette to looke on them and please herself with their Sport, and then shee would act the like sport herself with *her* stallions One of her great gallants was crooke-back't Cecill, earl of Salisbury"<sup>20</sup> What is recorded in the first part of this passage does not appear to me unconsonant with the frank Renaissance attitude toward nature and beauty, something which John Aubrey, and perhaps the seventeenth century, would not understand; therefore, the conclusion by way of inference (The "contrivance" and "vidette" sound to me like a coy seventeenth-century invention) Although there is no evidence of such relations, I would not question, in the light of Elizabethan background, that there may have been amours in the life of the Countess of Pembroke, either during her marriage or after her husband's death; it is improbable that her marriage was a love match, Henry Herbert was forty-three and Mary Sidney sixteen, and she was only forty when Henry Herbert died. That she was the object of promiscuous gallantry, as Aubrey implies, is utterly incongruous with the records of her character and background

I will add one stray instance of Aubrey's inconsistencies In the life of Philip Sidney he records that he loved his wife very well; in the life of the Countess of Pembroke he records that Philip Sidney was the father of her son Philip. Sidney was married in 1582, and his nephew Philip was born in 1584 Perhaps the two statements were entirely compatible to Aubrey's mind

Hunting John Aubrey's bits of gossip may seem like shooting clay pigeons, but a few pages in such a book as Dr. Sargent's can give a bit of gossip wings The realization of Hoyt H. Hudson's suggestion, "We may look for the appearance of a new work, identi-

<sup>20</sup> *Scandals and Credulities*, p. 12.

ying Stella as the Countess of Pembroke,"<sup>40</sup> is not utterly remote Dr Sargent does not accept Aubrey's statement in its full scope or offer his supporting evidence as more than hypothetical arguments. But instead of subjecting the statement to critical examination he adds to its weight, and leaves the impression of at least some sort of half-truth in the charge of incest. The interest and merit of Dr Sargent's book add to the importance of correcting the impression conveyed by the few pages discussed.

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<sup>40</sup> Offered as the height of absurdity in a footnote, p. 105, of *Penelope Devereux as Sidney's "Stella"* (Huntington Library Bulletin, No. 7, April, 1935), a comprehensive reply to James M. Furcell's argument against Penelope Devereux as Stella, in *Sidney's Stella* (New York: Oxford University Press, 1934).





## THE SCHOLAR IN A DEMOCRACY OUTPOSTS IN THE ATTACK UPON THE IVORY TOWER FROM EMERSON TO WILSON

MENTOR L. WILLIAMS

OF THE problems facing the scholar in the democratic nations none are more difficult of solution or more important than the extent and the character of his participation in the civic and social affairs of his time. Tensions pull him hither and yon "Go fight the battles of humanity", "Withdraw from this hurly-burly", "The future of civilization depends on the scholar's efforts to preserve it", "Only by the scholar's remaining aloof can sanity and right reason be kept alive in this world of chaos." Faced with these conflicting attitudes where will the scholar turn? Arguments, even threats, are used to drive him forth or hold him back. The American Writers Congress indicts the writer or the thinker who remains aloof from the present struggle, so, too, the Artists Guild, the Lawyers Guild, the Federation of Teachers, *The Social Frontier*, and a host of other organizations and organs. Malraux and Mann take up the cudgels for action. *New Masses* prints a series of articles by scholars and scientists, like J. B. S. Haldane, telling why they deserted the quiet fastness of the ivory tower for the turmoil of the battle front.<sup>1</sup> For the other side *The Atlantic Monthly* publishes a plea, its author being no less a personage than Mr. E. M. Forster.<sup>2</sup>

There is much that is praiseworthy in Mr. Forster's article. He points clearly to the factual duality in all men's lives — the need for solitude and the need for the multitude. Some men, like Milton, are able to satisfy both needs. Other men, he declares, must always be saving either themselves or the world, never both. Men who save themselves resort to the ivory tower. But, Mr. Forster believes, the

<sup>1</sup> Haldane, J. B. S., "Hitler Woke Me Up," *New Masses*, 30, February 28, 1939, 3-4.

<sup>2</sup> Forster, E. M., "The Ivory Tower," *The Atlantic Monthly*, 163 (1939) · 51-58

term "ivory tower" has fallen upon evil days, it has, unfortunately, become associated with the derogatory word "escapist." There was a time when "ivory tower" meant the withdrawal of the active man from the scene of action that he might contemplate the world as from a height, from a detached position. This was the sense in which Sainte-Beuve applied the phrase to his friend De Vigny. There was a time before that when the term meant the religious or the spiritual "retreat" of worldly men before plunging into the stress and strain of conflict. In one sense "ivory tower" connoted enlightened detachment, in the other it signified a source of strength. Mr Forster wistfully asks that we accept these meanings for "ivory tower" <sup>3</sup>

Neither of these definitions is attached to the phrase as it is applied today. By common usage the ivory tower now is an anti-social hiding place, deliberately sought and entered by the intellectual aristocrat, the élite humanist, by the bored, the indifferent, the disgusted, the self-interested, the fearful, and the timid members of the scholar class. It is clear that such persons are not increasing their intellectual perspective or drawing spiritual strength from their residence in *la tour d'ivoire*. Even Mr Forster holds no brief for those who retreat to intellectual quiescence from motives of fear. "We shut ourselves up there, trembling, doing nothing, afraid to face danger, and waiting from moment to moment for the blow that'll shatter our fragile fortress. . . . There's no release through it, and no creation" <sup>4</sup>. Mr. Forster does maintain, however, that boredom, disgust, indignation are valid motives for escape. Those suffering from such maladies can usefully retire to the tower, there they gain perspective and proper focus and contemplate events detachedly. <sup>5</sup> One may agree that the indignant intellectual could profit by the tower's discipline, but it is hard to imagine bored and disgusted scholars recovering their balance in such circumstances.

More and more, as crisis follows crisis, the modern scholar flees from the social realities. It is true, as Mr Forster asserts, that he does not flee from life; he flees to a different life, a private, solipsistic world which is just as real as the social world <sup>6</sup>. The difference lies in the fact that in the private world the problems confronted are of his own making, while the public world thrusts problems upon him. As

<sup>3</sup> Forster, *op cit*, p. 51.

<sup>4</sup> *Ibid.*

<sup>5</sup> *Ibid.*, p. 56.

<sup>6</sup> *Ibid.*, p. 55.

social confusion and instability increase the scholar tries to escape the responsibility of choosing a course of action. By withdrawing into a compartmentalized universe of his own he can shut out those affairs that would cause him pain or psychological imbalance or economic insecurity. From that comfortable solitude he does not contemplate events or meditate on the future of man; he engages, instead, in some activity which makes him forget man as a social organism. In the language of modern problem solving this escape is called "diversion", personal security lies in not seeing, in shutting out. It is this type of ivory-tower occupant that is inveighed against by the left-wing critics. For this "escapist" not only denies his community the higher services which alone might save it and which in a sense, certainly in a democracy, he owes to his community because it made cultivation of his powers possible, but also abets the forces of unreason, barbarism, and reaction through his inactivity by giving tacit assent to their programs of destruction. If democracy is to succeed or survive it is only on the assumption that every citizen has a stake in its success, and that stake may even be the very possibility of spiritual retreat or intellectual rustication which the escapist demands for himself. One may blithely chant

Stone walls do not a prison make  
Nor iron bars a cage,

yet totalitarian prisons and cells are not equipped so comfortably as the ivory towers provided by the democratic state. Democracy assumes that every citizen must contribute of his time, his labor, his energy, his skill, and his talent if it is to succeed. Democracy demands fraternity of effort and service of the scholar as of everyone else. Of course, if the scholar does not believe in democracy that is quite another matter; we are concerned only with the duty of the scholar who accepts the ideology of democracy.

Rather than rise to the exalted task assigned to the educated class in a democracy scholars have for the most part attempted to play the rôle of neutrals in a world where neutrality is impossible. The bogey of learning is the fear of partisanship. The partisan student, it is claimed, will contaminate his data with his bias, will weight his evidence, will distort to prove his conclusions. To get at truth the investigator must be cold, aloof, scientific (as if any scientist were ever a cold, passionless automaton). Partisanship allows the

free play of the passions, passion has no place in scholarship. The scholar, in his most deluded moments, believes that after the passions have wrought destruction he can patch up the pieces. Such delusion might be called the "After-the-deluge-me" attitude, to reverse the ancient French maxim. It is an excellent example of the self-hypnotism to which too much rationalization leads. After the deluge there may not be a place for scholarship, for culture, for individual development as those terms are now understood, there are too many modern examples of the destruction of civilized, humane cultures in the world — destroyed partly because the intellectual failed to realize or realized belatedly that his type did not have and could not claim any peculiar immunity. Democracy has so far offered the scholar the greatest opportunity for the pursuit of both humane and scientific aims, the scholar, in turn, must preserve that democracy which gave him the fields and the freedom to investigate them.

If we look back at American educational philosophy, we find that democracy and scholarship have always been focal issues. As often as the current distrust of democracy reached the point of asserting "Democracy has failed," some clear-sighted critic arose to demand that the educated class return to the post of duty. Again and again the intellectuals have been warned against alienating themselves from sociocivic affairs, again and again our critics have attacked the ivory tower, have charted the course of action for the scholar in a democracy. Democratic education has continued (the more sanguine believe it has progressed) because of these constant frictions, constant challenges, constant revaluations. From Emerson to Wilson, to mention as convenient terminal points two men who delivered Harvard Phi Beta Kappa addresses, Americans have been told that the scholar must live in America, not in the thrice-rarefied atmosphere of an intellectual cell or a palace of art.<sup>7</sup> There may be newer weapons in democracy's armory, but there are few better than those which were employed by its defenders between 1837 and 1909.

<sup>7</sup> There are, literally, dozens of essays and addresses (many of them preceding Emerson) which stress the relation of the American scholar to democratic society. Those chosen for this discussion are simply the most pointed ones. See Albert H. Marcwardt, "The American Scholar," *Pap. Mich. Acad. Sci., Arts, and Letters*, 18 (1933) 525-538, and Bliss Perry, "Emerson's Most Famous Speech," *The Praise of Folly and Other Papers* (Boston, 1923), pp. 81-113, for comment on early addresses on this subject.

When Emerson went to Cambridge in 1837 to deliver the Phi Beta Kappa address<sup>8</sup> scholarship was at a low ebb. A veritable *Weltschmerz* had settled upon American learning. The air was "thick and fat", scholars were "decent, indolent, complaisant"; young men of promise, repelled by low, materialistic aims, "turned drudges, died of disgust, some of them suicides"<sup>9</sup>. The democratic experiment of Jackson had expired in a stagnant backwash. Into this pessimistic atmosphere charged young Longfellow and young Emerson, the one to deny the emptiness of life,<sup>10</sup> the other to declare the duties of the educated class.

There goes in the world a notion that the scholar should be a recluse, a valetudinarian, — as unfit for any handiwork or public labor as a penknife for an axe. As far as this is true of the studious classes it is not just and wise. Action is with the scholar subordinate, but it is essential. Without it he is not yet man. Inaction is cowardice, but there can be no scholar without the heroic mind. Only so much do I know as I have lived.<sup>11</sup>

Free should the scholar be, — free and brave. Free even to the definition of freedom, "without any hindrance that does not arise out of his own constitution". Brave, for fear is a thing which a scholar by his very function puts behind him. Fear always springs from ignorance. It is a shame to him if his tranquility, amid dangerous times, arise from the presumption that like children and women his is a protected class, or if he seek a temporary peace by the diversion of his thoughts from politics or vexed questions, hiding his head like an ostrich in the flowering bushes, peeping into microscopes, and turning rhymes, as a boy whistles to keep his courage up. So is the danger a danger still, so is the fear worse. Manlike let him turn and face it. Yes, we are the cowed, — we the trustless.<sup>12</sup>

Emerson's address was a miraculous tonic to the jaded young scholars. "The young men went out from it as if a prophet had been proclaiming to them, 'Thus saith the Lord!'"<sup>13</sup>

A new generation of students, however, found their masters gone over wholly to Mammon and to slavery. By 1849 it was time, high time, that a new voice should ring, clarion-like, upon the ears of youth. Addressing the students of Colby College,<sup>14</sup> Theodore Parker, fiery minister of "Twenty Eighth," began.

<sup>8</sup> Emerson, R. W., "The American Scholar," *The Complete Works of Ralph Waldo Emerson* (Centenary Edition, Boston, 1903), I: 81-115.

<sup>9</sup> *Ibid.*, I: 114.

<sup>10</sup> "The Psalm of Life" (1839).

<sup>11</sup> Emerson, *op. cit.*, I: 94-95.

<sup>12</sup> *Ibid.*, I: 104-105.

<sup>13</sup> Holmes, O. W., *Ralph Waldo Emerson* (Boston, 1885), p. 115.

<sup>14</sup> Parker, Theodore, "The Position and Duties of the American Scholar — An Address Delivered at Waterville, August 8, 1849," *Speeches, Addresses, and Occasional Sermons*, 3 vols. (Boston, 1861), III: 346-410.

Men of superior culture get it at the cost of the whole community, and therefore, at first owe for their education. They must pay back an equivalent, or else remain debtors to mankind, debtors forever; . . . the graduate has been a long time at school and college; not earning but learning, living therefore at the cost of mankind, with an obligation and an implied promise to pay back when he comes of age and takes possession of his educated faculties<sup>15</sup>

But the scholar of the day was neglecting his obligation; he was "slipping into other modes of action," Parker asserted. "The Pen stoops to the Office, that to the purse . . . The college is named after men of wealth, not genius"<sup>16</sup> Yet

the scholar never had so fair a chance before . . . There are great wrongs which demand redress; the present men who represent the Office and the Purse will not end these wrongs. Shall it be only rude men and unlettered who confront the dragons of our time while the scholar, the appointed guardian of mankind, but "sports with Amaryllis in the shade, or with the tangles of Nessra's hair?" The nation asks of her scholar better things than ancient letters ever brought; asks his wonders for the million, not for the few alone<sup>17</sup>

When Wendell Phillips delivered his blistering attack upon the hunker character of Harvard education in 1881<sup>18</sup>—again to the brothers of Phi Beta Kappa—he chose two ideas which formed the keynotes of his entire oration. The first, taken from Jeremy Taylor, condemned unprofitable and ineffective contemplation. The second, taken from Disraeli, condemned distrust of the people. In powerful, scathing terms Phillips passed in review the reforms of the century and charged the scholar class with gross neglect of duty.

"Rarely in this country have scholarly men joined as a class, in these great popular schools, in these social movements which make the great interests of society 'crash and jostle against each other like frigates in a storm'" . . . Amid the battles "scholarship sat dumb for thirty years"<sup>19</sup> And the reason lay in the fact that the educated classes shrank from contact with the masses.

Fifty million of men God gives us to mould; burning questions, keen debate, great interests . . . , sad wrongs . . . —these are the people's schools. Timid scholarship either shrinks from sharing in these agitations, or denounces them as vulgar and dangerous interference by incompetent hands with matters above them. A chronic distrust of the people pervades the book-educated class of the North; they shrink from that free speech which is God's normal school for

<sup>15</sup> Parker, *op cit.*, III: 346-347.

<sup>16</sup> *Ibid.*, III: 374-377.

<sup>17</sup> *Ibid.*, III: 406-407

<sup>18</sup> Phillips, Wendell, *The Scholar in a Republic*. Boston, 1881.

<sup>19</sup> *Ibid.*, pp. 22-23.

educating men, throwing upon them the grave responsibility of deciding great questions, and so lifting them to a higher level of intellectual and moral life. Trust the people — the wise and the ignorant, the good and the bad — with the gravest questions, and in the end you educate the race.”<sup>20</sup>

Very pleasant it is to sit high up in the world's theatre and criticize the ungraceful struggles of the gladiators, shrug one's shoulders at the actors' harsh cries, and let every one know that but for “this villainous saltpetre you would yourself have been a soldier.” But Bacon says, “In the theatre of man's life, God and his angels only should be lookers-on.”<sup>21</sup>

“College-bred men,” said Phillips, must “lead in the agitation of the great social questions which stir and educate the age.”<sup>22</sup> There can be no leadership if these men sneer at the weaknesses of the stupid multitude, because there is neither belief, nor trust, nor sympathy in them.

In 1890, when the local and national democratic practices had reached a new low in corruption and when men again despaired of making democracy work, Henry C. Potter undertook to rouse the nation's intellects in an oration titled *The Scholar and the State*.<sup>23</sup> After sketching the political, economic, and moral chaos of the period he cleverly pushed the educated man out on the gangplank for the fatal plunge.

Why intrude upon us here, it may be asked, a theme so distasteful and facts so painful? Leave partisan issues to partisan strife. Here, within this classic horizon, let us seclude our little world, from which the noisy echoes and tainted airs of that other are carefully excluded.

The phraseology may seem exaggerated, but not, I think, that attitude of many learned men which it describes. To hold one's self aloof, not alone from contacts, but from questions which immediately concern the public welfare, is a temptation to which I fear the scholar is too often wont to yield. Amid the noisy clamor of some personal contest for place or power, he pierces the dust of the arena and sees the greater issues that lie beyond. To awaken interest in these, to secure even an intelligent appreciation of them, he has found so difficult and so unprofitable a task that he has long ago abandoned it in despair. And yet, here, I am profoundly persuaded, is the preëminent vocation of the scholar in our time. . . .<sup>24</sup>

For, whatever may be the limitations of other men, three forms of service for the state are equally competent to educated men, and each one of them is of signal importance.

(1) It is the function of learning accurately to observe and discriminate. “How far are our better-trained minds employing their attainments in the service of their fellow-men for the discernment and detection and exposure of popular errors?” . . .

<sup>20</sup> *Ibid.*, pp. 15-16.

<sup>21</sup> *Ibid.*, p. 31.

<sup>22</sup> *Ibid.*, p. 21.

<sup>23</sup> New York, 1890. This address, too, was delivered to the Harvard Phi Beta Kappa.

<sup>24</sup> *Ibid.*, pp. 22-23.



(2) The interpretation of truth [insures] the being and the well-being of the whole country, .

(3) And still above this is that highest duty of the scholar to the state which consists in his active participation and in his scrupulous discharge of the duties of citizenship<sup>26</sup>

E L Godkin, capable, hard-headed editor of *The Nation*, was often heard on his favorite subject, education. In one of his more distinguished articles, "The Duty of Educated Men in a Democracy," published in *Forum*, 1894, Godkin placed his finger squarely on the real obstacle to achieving a successful democracy. Remember that the Populist era was one to try men's souls and that the "great depression" began in 1893.

There is, probably, nothing from which the public service of the country suffers more to-day than the silence of its educated class, that is, the small amount of criticism which comes from the disinterested and competent sources. It is a very rare thing for an educated man to say anything publicly about the questions of the day. He is absorbed in science, or art, or literature, in the practice of his profession, and if he has any interest at all in public affairs, it is a languid one. He is silent because he does not much care, or because he does not feel that anything he could say would make much difference.<sup>27</sup>

Since opinions change gradually and since opinions in a democracy shift in proportion as they are talked about, Godkin concluded that "one of the functions of an educated man is to talk, and, of course he should try to talk wisely."<sup>28</sup>

By 1909, when Woodrow Wilson was asked to deliver the Harvard Phi Beta Kappa address,<sup>29</sup> democratic education had begun to express itself in vocational and professional study. The old idea of a college was fast disintegrating, it was losing its definiteness of aim, students in college, coming from an atmosphere of business, no longer wished learning. Democracy was "failing" again because the educated classes were shirking their obligations.

Here is the key to the whole matter: the object of the college, as we have known and used and loved it in America, is not scholarship (except for the few, and for them only by way of introduction and first orientation), but the intellectual and spiritual life. Its life and discipline are meant to be a process

<sup>26</sup> Potter, *op. cit.*, pp. 24-27.

<sup>27</sup> Godkin, Edwin L., "The Duty of Educated Men in a Democracy," *Problems of Modern Democracy* (New York, 1896), p. 211.

<sup>28</sup> *Ibid.*, p. 224.

<sup>29</sup> Wilson, Woodrow, "The Spirit of Learning," *College and State*, 2 vols. (ed. by R. S. Baker and W. E. Dodd, New York, 1925), II, 102-110.

of preparation, not a process of information. By the intellectual and spiritual life I mean the life which enables the mind to comprehend and make proper use of the modern world and all its opportunities. The object of a liberal training is not learning, but discipline and the enlightenment of the mind. The educated man is to be discovered by his point of view, by the temper of his mind, by his attitude towards life and his fair way of thinking. He can see, he can discriminate, he can combine ideas and perceive whither they lead, he has insight and comprehension. His mind is a practised instrument of appreciation. He is more apt to contribute light than heat to a discussion, and will oftener than another show the power of uniting the elements of a difficult subject in a whole view, he has the knowledge of the world which no one can have who knows only his own generation or only his own task.

What we should seek to impart in our colleges, therefore, is not so much learning itself as the spirit of learning. You can impart that to young men, and you can impart it to them in the three or four years at your disposal. It consists in the power to distinguish good reasoning from bad, in the power to digest and interpret evidence, in a habit of catholic observation and a preference for the non-partisan point of view, in an addiction to clear and logical processes of thought and yet an instinctive desire to interpret rather than to stick in the letter of the reasoning, in a taste for knowledge and a deep respect for the integrity of the human mind. It is citizenship of the world of knowledge, but not ownership of it.<sup>29</sup>

My plea, then, is this that we now deliberately set ourselves to make a home for the spirit of learning that we reorganize our colleges on the lines of this simple conception, that a college is not only a body of studies but a mode of association, that its courses are only its formal side, its contacts and contagions its realities. It must become a community of scholars and pupils, — a free community but a very real one, in which democracy may work its reasonable triumphs of accommodation, its vital processes of union. I am not suggesting that young men be dragooned into becoming scholars or tempted to become pedants, or have any artificial compulsion whatever put upon them, but only that they be introduced into the high society of university ideals, be exposed to the hazards of stimulating friendships, be introduced into the easy comradeships of the republic of letters. By this means the class-room itself might some day come to seem a part of life.<sup>30</sup>

Thus for nearly a century the critics of American life have challenged the scholar's right to retire from active participation in the affairs of the democracy. The emphasis shifts, the arguments follow changes in situation, but the tenor of the criticism remains the same. To summarize

1 The scholar in a democracy must recognize the nature and character of democratic education. Education is shared experience, foresight, wisdom, and power — all persons must participate in it, the scholar more than anyone else because his responsibility is greater

<sup>29</sup> *Ibid.*, II. 109-110

<sup>30</sup> *Ibid.*, II. 118-119

2 The scholar must achieve a clearer view of the whole of American life to be able to evaluate the parts, to realize the total unity of human experience

3 The scholar must achieve this clearer view of life through active participation in it; he may not pass judgment upon his society until he has contributed to it or been part of it. This view does not preclude the idea of a "retreat" for purposes of gaining strength or perspective; it does preclude the deliberate adoption of indifferentism or boredom as the motive for escape to an ivory tower

4. Finally, we see that each critic has singled out some cherished phase of the isolationist position for special censure. Emerson attacked timidity, Parker assailed self-interest, Phillips condemned distrust and the drawing away of academic skirts from contact with the vulgar mob; Potter lashed out against despair and hopelessness, Godkin decried the silence of the scholar, and Wilson demanded that scholars begin living by transforming the classroom into a place of action

As long as challengers like these continue to prod the scholar, as long as we have spokesmen who denounce the inertness of the educated class, the scholar will, *perforce*, continue to serve democracy. Then, but only then, can we cease fearing for its continuation or its success.

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# **PSYCHOLOGY**



## STANDARDS AND GOALS IN LEARNING

DAVID M. TROUT

FOR several years confusion and controversy have characterized many discussions of the law of effect. No other law of learning has been more persistently attacked, nor has any other one been more vigorously defended. The purpose of this paper is to present new data and a point of view which may clarify certain phases of the problem.

According to Thorndike, the outstanding champion of the law, the connection between a situation and a response is strengthened if the response is satisfying to the respondent, if the response is unsatisfactory, the connection between that situation and an alternative or opposite response is strengthened.<sup>1</sup> This means that satisfying responses are more apt to recur *because of the satisfyingness*, and that unsatisfactory responses are less likely to be elicited *because of dissatisfyingness*. Such a statement suggests and Professor Thorndike insists that, in some way not yet understood, the satisfying aftereffect of a response works back over and strengthens the connection, and that the same backward working of dissatisfaction strengthens alternative or opposite connections.<sup>2</sup> He mentions many examples of satisfiers and annoyers which produce these backward-working aftereffects. Among them he specifically includes self-approval and sense of failure or knowledge that a performance is wrong.<sup>3</sup> The data we are about to consider pertain particularly to these latter forms of satisfaction and dissatisfaction.

Just how the experience of satisfaction could work backward over neurons and synaptic connections<sup>4</sup> or strengthen their readiness for repetition of a response already performed is difficult to understand. It all seems contrary to the logic of science and to what is known

<sup>1</sup> Thorndike, E. L., *Human Learning* (New York: The Century Co., 1931), p. 101.      <sup>2</sup> *Ibid.*, pp. 32, 62.      <sup>3</sup> *Ibid.*, p. 36.

<sup>4</sup> For Thorndike's varied but consistent uses of the word "connection" see *Human Learning*, pp. 62-63.

about neural functions. Other fallacies in the law as now formulated have been pointed out by Wheeler and Perkins,<sup>5</sup> Tolman,<sup>6</sup> Cason,<sup>7</sup> and several others.

Numerous experiments in which both persons and lower animals served as subjects have been performed to test the validity of this law. These fall roughly into three classes (1) those in which neither the experimenter nor the subject seems to observe probable cues for reperformance, (2) those in which the experimenter apparently overlooks the fact that an organism may be controlled by many intrafocalized goals, all of which are operating simultaneously in organizing the response; and (3) those which are concerned with so-called "latent" learning.

Typical of the first class are several experiments reported by Thorndike.<sup>8</sup> Neither the experimenter nor his subjects observed probable cues for reperformance. It was easy to conclude that no such cues existed, and that the recurring response was due solely to the backward working of satisfying aftereffects. It cannot, however, be logically assumed, either because an experimenter does not observe such cues or because a human subject is unable to verbalize them, that they do not exist. The learner, after many weary trials in a stylus maze will, with unexpected suddenness, master it, but be wholly unable to describe any cues which guided his suddenly rapid success. Inability to recognize the cues from which suggestions are derived accounts for much modern propaganda, and for many of the misleading reports of spiritistic phenomena. It is an extremely subtle source of error in many learning experiments.

The experiments in the second class are exemplified by those which Peterson<sup>9</sup> and Gilliland<sup>10</sup> have reported. When an organism is guided by several intrafocalized goals or objectives, punishment or other dissatisfying effects attending the achievement of a secondary

<sup>5</sup> Wheeler, R. H., and Perkins, F. T., *Principles of Mental Development* (New York: Thomas Y. Crowell Co., 1932), pp. 359-361.

<sup>6</sup> Tolman, E. C., *Purposive Behavior in Animals and Men* (New York: The Century Co., 1932), pp. 341-345, 362-364.

<sup>7</sup> Cason, H., "Criticism of the Laws of Exercise and Effect," *Psychol. Rev.*, 31 (1924) 397-418.

<sup>8</sup> Thorndike, *op. cit.*, Lecture 3.

<sup>9</sup> Peterson, J., "Learning When Frequency and Recency Factors Are Negative and Right Responses Are Painful," *Psychol. Bull.*, 28 (1931) 207-208.

<sup>10</sup> Gilliland, A. R., "The Law of Effect in Learning," *Journ. Comp. Psychol.*, 24 (1937) 495-504.

goal in the series may, in terms of the law of effect, be neutralized by the satisfaction which results from the attainment of the ultimate goal in that series. It is conceivable, in terms of this law, that one might learn more quickly a punished than a nonpunished series of responses, provided the former culminated in more satisfaction than the latter. It is not difficult, therefore, to understand how data from experiments of this sort may be used either to defend or to attack the law of effect.

The "latent" learning experiments which constitute the third class are reported by Blodgett,<sup>11</sup> Tolman and Honzik,<sup>12</sup> Williams,<sup>13</sup> and others. Such studies suggest that learning occurs even when no satisfaction due to goal achievement is possible. It is difficult, however, to determine whether such learning takes place independently of goals as factors. The organism is often penalized with error credits because the goals which it is pursuing are not recognized by the record-keeping experimenter. The subject in a stylus maze may, for example, decide to explore the entire maze before undertaking to learn the "right" path required by the experimenter. Should such a subject be credited with numerous errors because his secondary goal, preliminary exploration of the maze, is not recognized by the experimenter? It seems equally probable that a rat is responding in a manner satisfying to itself when it wanders from one runway to another. If we avoid the egocentric predicament into which maze experimenters easily fall, the "latent" learning data so far reported do not appear to invalidate the law of effect.

Both the dialectic discussions and the interpretations of experimental results suggest that the real issue is whether the reperformance of an act is made more or less probable by its backward-working aftereffects or whether such probability is a function of environmental and intraorganismic cues which, when the organism reencounters a situation, reintegrate approximately the response which they had previously elicited. If, then, a situation can be devised in which these reintegrative cues can be controlled and in which satis-

<sup>11</sup> Blodgett, H. C., "The Effect of the Introduction of Reward upon the Maze Performance of Rats," *Univ. Calif. Publ. Psychol.*, 4 (1929): 113-134.

<sup>12</sup> Tolman, E. C., and Honzik, C. H., "Introduction and Removal of Reward, and Maze Performance of Rats," *Univ. Calif. Publ. Psychol.*, 4 (1930): 257-275.

<sup>13</sup> Williams, Katherine A., "The Reward Value of a Conditioned Stimulus," *Univ. Calif. Publ. Psychol.*, 4 (1929): 31-55.



faction and dissatisfaction are left free to operate as Thorndike claims they do, we should be able to obtain data relevant to the question at issue

Professor Thorndike's line-drawing experiments<sup>14</sup> suggested to me just such a situation. The modifications of his procedure which I have introduced to make it a suitable test of the law of effect will appear in the following paragraphs.

The preliminary experiments consisted of two parts. In Part A the blindfolded subject, with eyes closed, was instructed to draw, with evenly timed strokes, 100 lines each of which he judged to be 10 cm long. Sheets of paper 8.5 by 11 inches, with guide holes punched in the left-hand margins, were used. He was told to write *S* after each line with which he was satisfied, + (plus) after each one which seemed too long, and - (minus) after those which he regarded as too short. In Part B the subject, with eyes closed, drew a line intended to be 10 cm long, wrote *S*, +, or - after it, opened his eyes, measured it in millimeters, recorded the measure beneath the line, laid the ruler aside, covered the line by drawing a sheet of paper down over it, and repeated the performance until 100 lines had been drawn. He then measured the lines of Part A in millimeters.

Approximately 340 college students who had studied psychology one or more terms served as subjects. Their introspections and general behavior indicated excellent scientific morale. Since the data for all subjects are uniform in their indications regarding the operation of aftereffects, only a few representative cases are presented in Table I to indicate the general nature of the results obtained.

Several students remembered rather well the length of a 10-cm line. The better and the poorer results achieved by these are typified, respectively, by the records of 15A and 19B. The variations among those who stated that they had no idea what 10 cm meant are represented by the data for 2A and 22B. These latter subjects were almost wholly devoid of cues and would, therefore, be controlled by any other factors which might operate in the selection and fixation of a given line length.

If satisfaction works backward to strengthen the connections between situations and responses we can expect that in situations so equivocal, so devoid of environmental cues as these are, the satisfying line lengths will be progressively selected and fixated. But

<sup>14</sup> Thorndike, *op cit*, Lecture 1

examination of the data represented in Part A of Table I reveals neither selection nor fixation of any given length. There is so much overlapping of *S*, +, and - lines that they are hardly distinguishable from one another except by the signs following them. Conversely, if dissatisfaction works backward to strengthen alternative or oppo-

TABLE I

LENGTHS OF LINES DRAWN BY FOUR TYPICAL SUBJECTS WHO PARTICIPATED IN PARTS A AND B

Subject	2A		15A		22B		19B	
Part	A	B	A	B	A	B	A	B
S Extremes	146-198	83-116	65-127	82-124	14-44	75-119	41-81	73-117
+ Extremes	135-207	85-118	64-152	90-119	17-101	45-121	32-104	55-125
- Extremes	147-200	60-103	51-116	82-102	6-27	76-128	22-85	70-113
No of S lines	20	54	23	57	45	32	22	42
No of + lines	36	15	46	25	32	49	46	39
No of - lines	44	31	31	18	23	19	24	19
Q <sub>1</sub>	162 84	93 25	76 33	94 0	21 50	89 50	51 0	90 50
MD	175 33	98 71	95 0	100 0	30 67	95 40	64 75	101 0
Q <sub>3</sub>	186	104	117 66	105 16	42	102 67	71 75	109 13
Q	11 83	5 38	20 67	5 58	10 25	6 89	10 38	9 32

site responses, + and - lengths should have disappeared progressively in favor of the *S* lengths, but the data show that nothing of the sort happened.

When graphs of each subject's Part A lines were made, it became apparent that in every normally controlled case the lines grew progressively longer or shorter as the drawing proceeded. This drifting effect occurred without regard to the length of the lines being drawn. Subjects whose lines were much longer than 10 cm drew longer and longer lines, whereas others whose lines were shorter than 10 cm drew them shorter and shorter. Figure 2 is an illustration of this drifting. The phenomenon is contrary to expectations based on the law of effect.

In Part B, Table I, we see the results when a standard is introduced. Many of these lines — and the number increases consistently from first to last — fall within a rough Weber-Fechner limit of 97-103 mm. Note the medians and the *Q*'s for this part. Evidently the standard (cues which integrate attitudes or sets in the organism to draw the next line longer or shorter) gradually results in the selection and fixation of the length intended.

In order to amplify the results reported for Parts A and B ten subjects were asked to perform Parts C, D, and E

In Part C they were to respond as in Part A, described on page 612, except that they were told to draw 1,000 lines, each 15 "hexometers" long "Hexometer" was used fictitiously in order to make the situation more equivocal In Part D the subject drew lines 15 "hexo-

TABLE II

LENGTHS OF LINES DRAWN BY ONE SUBJECT WHO PARTICIPATED  
IN PARTS A, B, C, D, AND E

Standard	100	S Range	+ Range	- Range	S Total	+ Total	- Total	Median	Q
100 mm	A	70-110	55-114	50-105	30	36	34	87.66	9.20
	B	91-116	90-113	88-107	44	38	18	102.37	4.60
15 hexometers	1C	85-188	132-176	83-160	86	4	10	147.5	18.75
	2C	140-190	132-190	128-176	83	8	9	168.5	7.13
	3C	145-193	122-161	142-181	69	24	7	170.4	6.78
	4C	125-183	135-188	118-171	67	24	9	161.42	7.5
	5C	130-175	133-173	102-161	68	21	11	149.33	9.09
	6C	110-162	135-173	130-144	73	23	4	144.8	6.67
	7C	115-154	120-183	112-140	77	18	5	137.83	5.04
	8C	128-175	130-180	117-168	90	3	7	143.67	4.67
	9C	130-172	145-173	115-162	78	13	9	153.4	6.38
	10C	138-180	135-172	123-145	87	7	6	149.0	6.87
45 mm	1D	41-50	44-51	40-45	70	24	6	45.9	0.99
	2D	40-49	46-50	41-44	80	18	2	45.87	0.88
	3D	41-47	44-51	40-45	65	31	4	45.83	1.16
	4D	41-50	42-50	41-45	71	19	10	45.71	1.69
	5D	42-48	43-50	40-44	75	17	5	45.8	1.28
	6D	42-48	45-50	43-46	68	27	5	45.24	0.99
	7D	42-49	44-50	41-42	67	31	2	45.13	1.04
	8D	41-49	45-49	41-44	71	23	6	45.89	0.47
	9D	43-49	46-50	41-44	85	12	3	45.90	0.99
	10D	42-49	42-49	44	84	15	1	45.89	0.38
45 mm	1E	33-55	35-55	42-51	64	31	5	45.62	2.64
	2E	36-54	40-55	39-45	61	35	4	45.75	2.98
	3E	30-53	32-50	33-42	61	33	6	45.22	3.37
	4E	37-56	40-53	41-49	55	38	7	46.36	3.64
	5E	40-53	38-56	37-48	40	51	9	47.9	3.13
	6E	30-54	41-53	42-47	65	30	5	45.54	2.51
	7E	45-58	45-55	41-53	63	29	8	51.63	2.40
	8E	41-61	42-64	42-49	60	36	4	51.30	2.14
	9E	40-59	50-57	43-51	66	29	5	53.45	2.13
	10E	44-58	44-61	47-50	69	29	2	51.80	2.23

meters" long, as in Part B, after "hexometer" had been defined as 3 mm In Part E the subject was again blindfolded and told to repeat Part C. The results for one subject are given in Table II. The first column to the left shows the standard set in each of the five series, column 2, the parts of the experiment; 1C, 2C, etc, indicate

the first, second, and each consecutive 100 lines for Part C. The same designations are used for Parts D and E. The results given in Table II confirm those in Table I. Comparison of *Q*'s, extremes, and medians for these five parts indicates that satisfaction and dissatisfaction both fail to control selection or to increase fixation, but the introduction of a standard in Part D results in such a selection and fixation of line length that more than 50 per cent of the 1,000 lines fall within the kinesthetic Weber-Fechner limits below and above 45 mm.

Part E of Table II is especially interesting. There is a gradual increase in the median lengths of each successive 100 lines and a roughly corresponding increase in the number of satisfying lines. Here, without the standard to control the subject's responses, we see a marked drifting from the intended standard in spite of the obvious presence of satisfaction. This shows again that satisfaction neither selects nor fixates responses in a series.

In order to provide an even more equivocal line length the blind-folded subject was asked to draw whatever length was satisfying and to repeat it in accordance with procedure A. Results from one subject are shown in Figure 1. Finally, to give satisfaction every possible opportunity to operate in the selection and fixation of line lengths, the subject was instructed to close his eyes, draw a satisfying line, mark it *S*, +, or -, open his eyes, and, if it was marked *S*, contemplate it with satisfaction and pride, lines marked + or - were viewed with disfavor. The results from repeating this 100 times are shown in Figure 2. Circles indicate the occurrences of + or - (dissatisfying) lines in both figures. It is evident from these data that, even when the most favorable conditions for its operation are set up, satisfaction still fails to work in accordance with the predictions implied by the law of effect.

The data of this experiment seem to indicate two facts. (1) The law of effect as now formulated is invalid. Satisfaction and dissatisfaction do not work backward to strengthen or weaken connections between situations and responses. Even when the organism is freed as completely as possible from what might be interfering stimuli, the satisfaction of drawing and contemplating satisfyingly a given line length does not result consistently in even closely similar line lengths in the next and successive trials. (2) Standards, cues, stimuli which integrate an attitude or set of the organism to respond

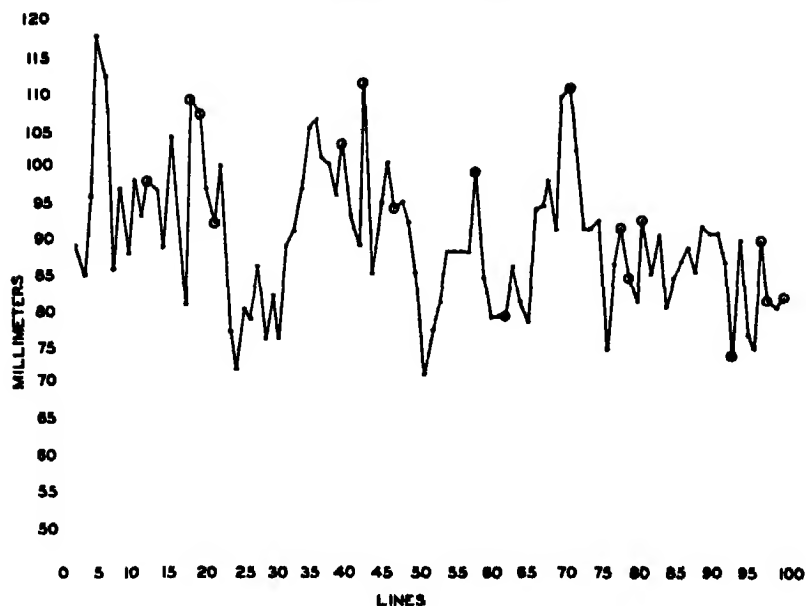


FIG 1 Distribution of line lengths when blindfolded subject drew a satisfying line and attempted to repeat it 100 times. Zero indicates occurrence of dissatisfying lines

in a particular way are effective factors in the selection and fixation of a common line length

In Parts A, C, and E such standards as were available to the subject (size of the paper, his own space-time orientation, previously established relations of kinesthetic and auditory stimuli to verbalized concepts such as centimeter, inch, etc.) controlled somewhat the length of the line drawn. Even in these parts learning occurred, for in its broadest sense any reorganization of a response in the effort to achieve a goal, however weak its valence, is learning, but this is not the progressive kind of learning attributed to the after-effects of a response. Progressive learning involves the negotiation of a recognized difference between a performance and a standard of action. Such learning did not occur in Parts A, C, and E.

When satisfaction and dissatisfaction are regarded as epiphenomenal the results of this experiment are seen as logical expectations. If we think of a goal as an anticipated condition of increased or-

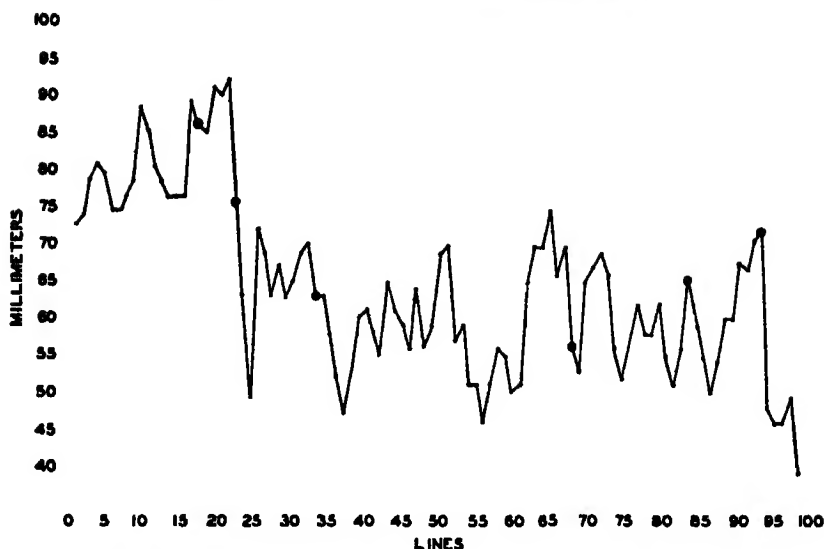


FIG 2 Distribution of 100 lines when subject closed eyes, drew a satisfying line, contemplated it, covered it, and repeated the response. Zero indicates unsatisfactory responses.

ganismic equilibrium, the conscious sign of which is satisfaction, it follows that satisfaction and dissatisfaction increase and decrease, correlatively, with increase and decrease of such equilibrium. Now, according to the law of least action,<sup>18</sup> we may expect an organism to "gravitate" toward equilibrium at all times, not because it derives satisfaction from such a condition, but because when stimuli, cues, and standards are all lacking there is nothing to prevent it from doing so. From this point of view both satisfaction and dissatisfaction appear as epiphenomenal conscious correlates, respectively, of increased and decreased organismic equilibrium. Neither of them operates as a factor in selecting or fixating successive responses.

But if satisfaction and dissatisfaction do not work backward, how does the organism anticipate equilibrium or disequilibrium? When it enters a situation similar to one which has previously ended in relative equilibrium, stimuli reintegrate approximately the previous organismic pattern. The neural core of this pattern, owing to the instability of neural protoplasm and its rapid rate of trans-

<sup>18</sup> Wheeler and Perkins, *op cit*

mission, is integrated in advance of neurally external temporal and spatial events. The consciousness of the goal is a correlate of this neural core, and in this way the organism "anticipates," as we say, equilibrating and disequilibrating conditions.

The point of view and the data here presented suggest the following conclusions: (1) Satisfaction and dissatisfaction are epiphenomenal correlates, respectively, of organismic equilibrium and disequilibrium. (2) In the absence of stimuli a condition of equilibrium with its attendant satisfaction would ensue. Negative adaptation and rationalization modify the degree or intensity of satisfaction experienced even when stimuli are present. (3) Stimuli throw the organism out of equilibrium and control its return to this state. Redintegrative stimuli, cues, standards set the conditions for return to equilibrium, and the process of returning is progressive learning. (4) Therefore, if we regard any redintegrative stimulus or cue as a determinative standard of action, it follows that standards and goals, not their epiphenomenal conscious correlates, satisfaction and dissatisfaction, are the essential factors in progressive learning.

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## **SOCIOLOGY**





## PRELIMINARY REPORT ON A SCALE FOR PREDICTING ADJUSTMENT DURING PROBATION OR PAROLE

STUART LOTTIER

ONE way of studying the etiology of delinquency is to determine factors associated with success or recidivism during probation or parole. This method is developed with respect to parole by such writers as Burgess, Clark, the Gluecks, Hart, Laune, Tibbitts, Van Vechten, Vold, and Warner;<sup>1</sup> and as regards probation by Monachesi, Reuben,<sup>2</sup> and others. In summary these studies demonstrate that failure is associated with previous criminal record, irregular work history, residence in cities and particularly in deteriorated areas of cities, marital maladjustment or no marriage, vicious habits such as alcoholism, drug addiction, and sexual deviation, and unfavorable psychiatric impression. They show only a slight relation between failure and intelligence, education, religion, early family background, physical condition, occupation, and psychiatric classification as distinguished from prognostic impression.

The research method by which the foregoing conclusions were

<sup>1</sup> Burgess, E. W., Chap. 28 in *The Workings of the Indeterminate Sentence Law and the Parole System in Illinois* (Springfield, 1928) by A. A. Bruce, E. W. Burgess, and A. J. Harno; Clark, W. W., "Success Records of Prisoners and Delinquents," *Journ. Delinq.*, 6 (1921) 443-452; Glueck, Sheldon and Eleanor T., *Five Hundred Criminal Careers* (New York, 1930); Hart, Hornell, "Predicting Parole Success," *Journ. Crim. Law and Criminology*, 14 (1923) 405-413; Laune, F. F., *Predicting Criminality* (Chicago, 1936); Tibbitts, Clark, "Success or Failure on Parole Can Be Predicted," *Journ. Crim. Law and Criminology*, 22 (1931) 11-50; Van Vechten, C. C., *A Study of Success and Failure of One Thousand Delinquents Committed to a Boys' Republic* (Chicago, 1935); Vold, Geo. B., "Do Parole Prediction Tables Work in Practice?" *Publ. Am. Social Soc.*, 25 (1931) 136-138; Warner, S. B., "Factors Determining Parole from the Massachusetts Reformatory," *Journ. Crim. Law and Criminology*, 14 (1923) 172-207.

<sup>2</sup> Monachesi, E. D., *Prediction Factors in Probation* (Hanover, 1932); Reuben, L. H., Jr., "Success and Failure of Adult Probationers in Wisconsin," (unpublished MS, Madison). See also Tolman, R. S., "Differences between Two Groups of Adult Criminals," *Genetic Psychology Monographs*, 20 (1938).

ascertained seems to constitute a significant departure from the purely descriptive methodology which characterized the study of crime until only a decade ago. Perhaps the primary distinction is that at the present time researchers seek to establish etiological sequences rather than descriptive criminal types. The sequences rest upon an organic view of relations between the offender and his total situation,<sup>3</sup> and are abstracted from all available data stated in terms of an operational<sup>4</sup> criterion like success or failure on parole. The earlier studies describe isolated factors without comparable controls. Moreover, present-day researchers use a new connotation of the term "significant". large differences between offenders or between offenders and nonoffenders are not anticipated for a given single factor; "significant" differences are expected to appear only when all factors are lumped or massed as a statistical whole.<sup>5</sup> Finally, investigators have abandoned dichotomous and absolute concepts and habitually regard all data as tendencies and exceptions. Also forgotten is the nonoperational conflict between quantity and quality and, therefore, between case method and statistical method.<sup>6</sup>

The resulting conception is that of crime and the criminal as symptoms rather than as conditions. This is an old idea, but today it is being applied in practice, at least in research practice. It appears that the etiological sequences that criminologists are building up are not etiologies of crime, but of something which, for lack of a better word, we may call "adjustment." Adjustment here is not in itself evaluative, but is used to denote an arrangement of conditions which cause or are associated with more or less arbitrary symptoms. The conditions are regarded as determinative of many symptoms, any of which may be chosen as an arbitrary criterion of adjustment. On the other hand, different arrangements of conditions may be distinguished as configurations, profiles, or *Gestalten* of the same evaluative symptom or criterion.

<sup>3</sup> Cooley, C. H., *Social Process* (New York, 1927), pp. 43-51; Wood, A. E., "Difficulties of Statistical Interpretation of Case Records of Delinquency and Crime," *Am. Journ. Sociol.*, 39 (1933), 204-209.

<sup>4</sup> Alpert, Harry, "Operational Definitions in Sociology," *Am. Sociol. Rev.*, 3 (1938) 855-861; Bridgman, P. W., *The Logic of Modern Physics* (New York, 1927).

<sup>5</sup> Hart, *op. cit.*, Sutherland, E. H., "Methodological Significance and Limitations of Specific Statistical Methods," *Journ. Social Forces*, 7 (1929), 561-563.

<sup>6</sup> Lundberg, G. A., "Quantitative Methods in Social Psychology," *Am. Sociol. Rev.*, 1 (1936): 38-54.

An illustration of the difference between conditions and symptoms is afforded by comparing a study in another field Viteles<sup>7</sup> examined eighty cab drivers employed for the same length of time by the Yellow Cab Company, of Philadelphia, to determine whether the sales performance of applicants for jobs could be predicted "A preliminary investigation had revealed no relationship between general intelligence and sales performance, the average intelligence level and spread of intelligence being practically identical for good, average, and poor drivers, as classified on the basis of gross revenue and earnings on a commission basis" Twenty-five items, including age, height, weight, schooling, work experience, marital status, health, working habits, economic and social responsibilities, number of accidents, and diseases, were compared with earnings Some factors were totally unrelated to earnings His general conclusions are as follows

The *Good Earner* is an older man, married, with a number of dependents He is physically fit He has, on the whole, stuck to such jobs as he has held for a number of years He is conscientious in reporting for work His objective in taking the job is more clearly defined than that of the poor earner His social status, on the whole, is a bit higher than that of the poor earner

The *Poor Earner* is a younger man, often single, or with few children, if married His physical condition borders on the unfit He tends to be a 'floater' so far as stability of employment is concerned He shirks work and sacrifices earnings for the pleasure of an evening's entertainment or the freedom of a week-end day He floats into, rather than seeks, the job His economic and social ideal are not as well developed as those of the good earner He is not less intelligent than the former, but temperamentally, in some cases, somewhat more unstable<sup>8</sup>

Viteles' cab-driver factors, applied to adult offenders, would differentiate those men more likely to succeed on parole, and, conversely, the criminologist's factors would distinguish good-earner cab drivers from poor-earner cab drivers. Both cab driving and crime may be regarded as symptoms, and apparently have etiological identities. As a matter of fact, the etiological researcher is not interested in cab driving or crime except as criteria of what we may call adjustment Criteria are intrinsically evaluative and as such are out of the realm of science. As etiological science, the only requirement is that they be stated in operational terms. How a man drives a cab or commits a crime is, as an isolated factor, only a symp-

<sup>7</sup> Viteles, Morris S., *The Science of Work* (New York, 1934), p. 170.

<sup>8</sup> *Ibid*, p. 172.

tom, and in reality is probably an infinitesimal part of his total adjustment. It is like a headache which, isolated, may be painful but is without meaning. Meaning or understanding is achieved by finding out what conditions are associated with the symptoms, to what extent these relate with each other, and whether patterns or *Gestalten* of factors are evident.

Several beliefs underlie this preliminary report of the attempt to develop a general scale for predicting outcome during probation or parole. These beliefs are loosely stated as follows: (1) The scale should rest on a general process like adjustment or some similar concept to include "success" during probation or parole and, possibly, a half dozen other arbitrary symptoms of adjustment; (2) One of the most objective and hence most predictive sources of data of social science is a good case history; (3) Prediction instruments to date have not exploited available case-history material because it is not readily abstracted into the necessary quantitative categories; (4) Competent case workers in courts and prisons can, without knowledge of the statistical studies, make predictive judgments with surprising accuracy; and prediction instruments to date have not exploited these subjective but accurate impressions because they are not in the necessary quantitative categories; (5) The simple instrument of the rating scale may be used to abstract and quantify the predictive essentials of both life histories and examiners' impressions; (6) The so-called objective and subjective data are not of different orders but are only the results of different attitudes on the part of different examiners, a prediction resting upon both sources of data would be more valid and more reliable because it would represent a more complete and hence a more objective consensus.

Investigation of this problem at the Psychopathic Clinic of the Recorder's Court, Detroit, Michigan, began year before last, a combination of common-sense and statistical methods being applied. The first step was the library work of listing, from all the probation and parole prediction studies, prereformatory factors shown to be associated with success or failure. After this, a wide variety of case histories was examined, and a second list was made, including the so-called subjective or impression factors of apparent predictive value. The only other criterion for the factors is that they be capable of convenient quantification on a continuum or scale. The result was the first trial form of the "Adjustment Prediction Rating,"

a mimeographed list of fifty-one factors, each classified or rated on a six-point scale. The rating of some ninety offenders showed, without formal analysis, that about a third of the factors, such as "Sick days, unable to work during year," did not distinguish first offenders from recidivists, other factors, like "Broken home," were discarded because they could not be defined with sufficient precision to make them reliable, and others, like "Number of delinquencies, parents and siblings," because they could not be ascertained with sufficient accuracy.

A second revision was made correcting the obvious errors and reducing the number of factors to forty-three. Since the problem of weighting could not be inferred from the statistical studies which do not include the so-called subjective or impression factors, the following questionnaire was submitted to thirty examiners, regarded as highly competent, including the professional staffs of the Michigan and the Illinois prison systems.

Problem. Which factors in an offender's case history do you consider, in general, most important for predicting future criminal behavior? Most case histories include the following ten classes of factors. Please number them from (1) most important, (2) second most important, etc., to (10) least important on the basis of your experience and judgment. The ten classes are here listed in alphabetical order.

- ( ) *Criminality*, present and past arrests and sentences
- ( ) *Education*, intelligence, school record
- ( ) *Family background*, parents and siblings
- ( ) *Habits*, recreation, drinking
- ( ) *Health*, physical complaints and defects
- ( ) *Marital adjustment*
- ( ) *Personal impression* upon examiner
- ( ) *Residence*, neighborhood, and mobility
- ( ) *Sexual adjustment*
- ( ) *Work record*, economic adjustment

What other factors not included in the above list do you consider important?

The twenty-eight questionnaires returned are sharply divisible into two groups. Eight examiners ranked family background first in predictive importance, and exhibited no other similarities except a tendency to put criminality and personal impression last. These eight examiners consisted of less formally trained workers. The other twenty all ranked either criminality or work record as most predictive. Of this group, the means of the ranks of the ten categories of factors and their standard deviations are as follows:

<i>Category</i>	<i>Mean</i>	<i>Sigma</i>
Criminality	1.4	.47
Work record	3.1	1.47
Family background	4.6	1.74
Habits	4.9	2.19
Residence	5.3	2.31
Personal impression	6.1	3.10
Education	6.3	2.47
Marital adjustment	6.7	1.84
Sexual adjustment	7.7	1.44
Health	8.8	2.06

The results are useful in confirming the general validity of the statistical studies and in suggesting the manner in which the various categories of factors might be weighted for maximum predictive validity.

The present scale, the fourth trial form, is made up of twenty-five factors of information and impression, each factor classified or rated on a five-point scale, from zero to four. The categories are weighted by the number of factors assigned to each, as follows:

<i>Category</i>	<i>No. of factors</i>
Criminality	6
Work record	5
Residence	3
Family background, habits, education, and personal impression, each	2
Sexual adjustment, marital adjustment, health, each	1

The Adjustment Prediction Rating, or APR, is the sum of these twenty-five ratings.

Directions for scoring and interpreting appear on the Adjustment Prediction Rating form as follows:

Score the Adjustment Prediction Rating (APR) as the final part of the usual life history interview. Refer to "Definition of Factors and Examples of Classification." Rate every factor while the offender is present. Rate each factor separately and independently as if each were the only factor you are considering. Information pertaining to residence, work record, and criminal record must be verified. Check the rating for each factor in its interval, entering specific information wherever possible: in rating factor 1, "room with wife," for example, should be written in interval zero rather than only checking interval zero. After rating every factor, total the checks for each interval and multiply each total by the value of the interval. The sum is the Adjustment Prediction Rating.

A scale of APR values suggesting the type of treatment required for adjustment may be constructed something as follows:

<i>Score</i>	<i>Suggested treatment</i>
0- 25	Needs intramural care
25- 40	Unlikely to adjust under supervision
40- 50	Specialized supervision
50- 65	Routine supervision
65- 75	Minimum supervision
75-100	Needs no supervision

But the APR has little general predictive worth because it is relative to and modified by (1) the operational criteria of adjustment what constitutes success or failure during supervision? (2) conditions of employment is the candidate able to obtain regular work? (3) facilities for supervision what services can the probation or parole officer offer the candidate? In practice, the APR for a given time and place should be statistically translated into an estimate of the percentage chances of success for a particular interval and quality of supervision. At worst, the APR is applied separately as meaningful in itself. At best, the APR classifies the average predictive essentials and supplements other findings.

To test the validity of the APR, one hundred selected cases have been rated, all being male white offenders between the ages of twenty and forty and all but several having been originally examined in the Psychopathic Clinic during 1938 and 1939. Group 1 is composed of fifty first offenders, Group 2 of fifty offenders who have been detained or arrested three or more times before, not including arrests for minor traffic offenses. Most but not all of Group 2 have been institutionalized by sentence one or more times. Each offender was examined in the usual way, for from three to eight or more hours by one of three examiners. The only exception to the requirements of the test was that about half of the ratings were done "cold," i.e. not in the presence of the offender, but no rating was done where the recorded history did not serve to recall a vivid impression of the individual. The range, arithmetic mean, and standard deviation from the mean for the two distributions is as follows:

<i>Group</i>	<i>Range</i>	<i>Mean</i>	<i>Sigma</i>
Group 1 (no arrests)	36-85	63.8	11.3
Group 2 (three or more arrests)	15-57	33.5	10.9

Four of the twenty-five factors have to do with previous criminal record: age at first delinquency, previous arrests, including those for juvenile but not for minor traffic offenses; previous sentences, including those to correctional school, and present criminal tendencies rated. The effect of these was removed by eliminating them entirely and distributing the scores on the basis of the twenty-one remaining factors. The corresponding data are as follows:



Group	Range	Mean	Sigma
Group 1 (no arrests)	23-69	49 0	10 3
Group 2 (three or more arrests)	13-48	29 4	9 2

Each of the four distributions is approximately normal because the mean, plus or minus the standard deviation in each distribution, embraces about two thirds of the cases

The critical score on the Adjustment Prediction Rating scale is 40. The scale of APR values indicates that an APR of 40 is on the margin between "Unlikely to adjust under supervision" and "Specialized supervision" required for likely success. Such a rating is not predictive, but as the APR proceeds away from 40 in either direction on the scale, it increases in predictive significance.

After the scale has been validated, the empirical critical position will be standardized for a given locality and time by (1) accumulating an experience of successes and failures according to (2) specified operational criteria (3) under different types of supervisory facilities, arrangements, and personnel, (4) during a known trend and phase of employment conditions with (5) further statistical corrections for any other known significant differential of time and place, such as the character and policy of labor organization, of industrial management, and of welfare and police agencies. It may well be shown that the statistical significance of changing societal conditions to which any prediction scheme must be adjusted is greater than the statistical significance of the conditioning factors which the scale purports to measure. By any meaningful criteria of success or failure, we have no evidence to make us expect that an offender with an APR well above 75 will adjust successfully when, for example, the factories are seasonally laying off men, the case load of probation or parole officers by reason of tax delinquencies or economy drives is taxed to double or treble its optimum capacity, or the police, under pressure of a press campaign, are rounding up "known criminals" night after night in a futile attempt to clear a sensational crime.

Work planned for the immediate future is (1) to rate a larger and more varied number of offenders as a basis for validating each factor of the instrument for prediction purposes, (2) to find out what combination of valid factors yields a total score of maximum predictive value, and (3) to compare the reliability of scores for the same offender by two or more examiners.

PSYCHOPATHIC CLINIC, THE RECORDER'S COURT  
DETROIT, MICHIGAN

## THE CHANGING SCHOOL POPULATION AND ITS IMPLICATIONS\*

JOHN FREDERICK THADEN

**D**URING recent years a fairly rapid change in the size of the public-school population has been taking place throughout the United States. It is the purpose of this paper to state that change as it manifests itself in Michigan and to consider its implications for education in the state.

Enrollment in the public schools of Michigan reached a peak of 1,049,505 in 1932, as is indicated in Table I, which gives the yearly enrollment in each grade from 1930 through 1938. The number of pupils in the various elementary grades has been declining since the early thirties, although registration is still increasing in the secondary-school grades, except possibly in the ninth. The enrollment in the elementary divisions dropped from 838,790 in 1930 to 691,544 in 1938, a decrease of 147,246, or 17.6 per cent. The decrease in the kindergarten and in the first, second, and third grades during the same period was much greater. From 1930 to 1938 enrollment in the kindergarten dropped from 102,799 to 65,710, or 36.1 per cent, in the first grade, from 115,817 to 82,335, or 28.9 per cent, in the second grade, from 100,168 (the enrollment reached a peak of 101,455 in 1929) to 78,811, or 21.3 per cent, in the third grade from 99,404 to 77,632, or 21.9 per cent; and lesser declines took place in the other grades. Thus, in 1938 as compared with 1930, there were 37,089 fewer children in the kindergarten, 33,482 fewer in the first grade, 21,357 fewer in the second, 21,772 fewer in the third, 16,470 fewer in the fourth, 7,908 fewer in the fifth, and fewer in the sixth and seventh grades also. There is, moreover, a smaller number of children in the eighth grade now than there was in the peak year 1932.

The phenomenon of a growing number of empty seats in the

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TABLE I  
ENROLLMENT IN THE PUBLIC SCHOOLS OF MICHIGAN, BY GRADES, 1930-38 \*

Grade	Year									Percentage of change, 1930-38
	1930	1931	1932	1933	1934	1935	1936	1937	1938	
Kindergarten	102,799	101,785	96,835	65,244	60,615	63,906	65,460	66,146	65,710	- 36 1
1	115,817	114,341	107,254	91,125	88,232	86,906	86,949	86,635	82,335	- 28 9
2	100,168	96,828	97,283	85,803	81,985	82,808	79,588	79,956	78,811	- 21 3 *
3	99,404	95,277	91,614	85,883	81,984	82,025	81,142	78,329	77,632	- 21 9
4	92,333	94,963	91,180	82,253	82,495	82,353	80,914	80,119	76,863	- 17 7
5	86,009	88,443	90,138	81,033	78,993	82,591	81,283	80,078	78,101	- 9 2
6	84,718	81,672	83,797	81,087	77,378	78,628	80,653	79,864	77,458	- 8 6
7	81,964	82,505	80,159	77,678	78,396	77,674	77,824	79,906	78,301	- 4 5
8	74,548	76,709	78,234	72,241	72,835	76,833	75,289	75,076	76,333	- 2 4
Total	838,790	832,523	816,494	722,347	702,903	713,724	709,104	706,169	691,544	- 17 6
9	60,959	64,012	65,847	62,579	62,508	66,577	69,994	66,847	68,845	12 9
10	47,680	53,959	58,581	55,767	54,254	54,828	58,738	60,378	60,737	27 4
11	33,074	38,107	43,645	44,327	43,307	45,577	44,975	47,667	52,258	58 0
12	25,308	29,619	34,142	38,237	39,437	39,773	40,804	39,991	43,495	71 9
Total	166,999	185,697	202,215	200,910	199,506	206,755	214,510	214,883	225,335	34 9
Others †	30,295	30,213	30,796	34,647	24,973	23,388	28,678	21,276	28,824	- 8 2
Grand total	1,035,084	1,048,433	1,049,505	957,904	927,382	943,867	952,289	942,328	945,703	- 8 7

\* Data obtained from the Michigan State Department of Public Instruction.

† Pupils at continuation school or in special rooms and classes, and postgraduates.

grades is quite general throughout the state. From 1930 to 1938 enrollment in the elementary divisions of the Detroit schools dropped from 213,369 to 176,419, a decrease of 36,950, in the Flint schools, from 28,542 to 23,583, and in the Grand Rapids schools, from 21,220 to 16,254.

Furthermore, a similar change is apparent the country over. Enrollment in the elementary schools of the nation fell from 21,135,420 in 1932 to 20,392,561 in 1936, a drop of 742,859 in five years. The decline in the number of pupils in the first grade of the public schools of the nation started in 1929 and since 1930 has averaged 100,000 children a year. "In 1932 there were approximately 221,000 fewer first-grade pupils than in 1930, a decrease of 5.3%."<sup>1</sup> The decline is progressing through the grades and has probably reached the eighth this year (1938).

#### DECLINING SCHOOL ENROLLMENT IN ITS RELATION TO A DECLINING POPULATION

The diminished enrollment in the elementary schools of the country is the resultant of two basic social forces, namely, a falling off in the absolute number of births and a slackening immigration. A contributing factor in Michigan is a lessened immigration from other states. The peak for births per year in the United States (2,958,000, according to Thompson and Whelpton,<sup>2</sup> who have made allowances for underreporting to the State Public Health Department) was reached in 1921. In 1935, in consequence, about 100,000 more children completed their education in the elementary schools than ever did before in a single year, or are likely to hereafter. By 1940, according to O. E. Baker,<sup>3</sup> there will probably be 200,000 fewer children fourteen years of age than there were in 1935.

Since 1924 the decline in births for the country as a whole has been almost continuous, averaging 55,000 a year from 1924 to 1930. During the depression years, 1931-33, it averaged 91,000 a year, apparently because of fewer marriages. As the economic depression

<sup>1</sup> Kandel, I. L., ed., *Educational Yearbook of the International Institute of Teachers College, Columbia University*, 1936, p. 600.

<sup>2</sup> Thompson, Warren S., and Whelpton, P. K., *Population Trends in the United States* (1933), p. 4.

<sup>3</sup> Baker, O. E., *The Outlook for Rural Youth*, U. S. Dept. Ext. Service Cir., 223 (1935) 22.

subsided the number of marriages increased, and a concurrent rise in births took place during 1934 and 1935

The high birth rate in 1921 and 1924 is now reflected in a maximum secondary-school enrollment, since the children born in those years are now about seventeen and fourteen years old, respectively Rufus Smith <sup>4</sup> notes that the peak year for births in both England and Germany was reached in 1908, some thirteen years earlier than the 1921 record of the United States

Despite the rapidly growing proportion of youth of high-school and college age attending school enrollment in the high school can be expected to decrease within three or four years and that in the colleges by about 1945 The United States Office of Education estimated that high-school enrollment would reach 6,135,000 in 1938-39, after which it would gradually subside Although the population of the United States increased by seventeen million from 1920 to 1930, there were 129,000 fewer children in 1930 than there were a decade before

The effect of fewer births in the late twenties is being felt in the high-school and college enrollments of a decade and a half to two decades later Baker <sup>5</sup> calls our attention to the fact that there are in the nation, in 1938, about 940,000 fewer children under six years of age than there were five years ago, a decrease of 7.5 per cent, and about 982,000 fewer children from six to nine years of age inclusive, a decrease of nearly 10 per cent Hence the million empty desks in the public schools of America this year are only a small fraction of the total number that will be empty in a few decades

Because of the rapidly expanding population which characterized this nation until recently it is not commonly realized that the birth rate has been declining for over a century Such a decline has been counterbalanced by an even greater drop in the mortality rate, and by extensive adult immigration Net immigration, which once averaged 400,000 annually, has been drastically restricted since about 1924, and excess of births over deaths has been dwindling since about the same year Whereas in the early twenties (1920-24) about 1,880,000 persons were being added to the nation each year,

<sup>4</sup> Smith, Rufus D, "Population and Schools," *Journ Ed Sociol*, 9 451 1936

<sup>5</sup> Baker, O E, "Population Prospects and Public Schools," *School Life*, 22 305 1935

a decade later (1930-34) the addition averaged less than half as many

Population growth is slowing up rapidly, and experts predict, on the assumption of medium fertility, moderate mortality rates, and limited immigration, that it will be virtually stationary at about 155,000,000 by 1960. The rising death rate, due to the rapidly increasing average age of the general population, will in the near future contribute considerably to the slowing-up process. The school is about the first institution to be affected by the declining number of births and by a slackening of population growth and, consequently, is among the first to face readjustment. It is estimated that by 1960 there will be about three million fewer school children to be educated than there are at present.

#### THE EFFECT OF A DECLINING SCHOOL ENROLLMENT ON THE SCHOOL SYSTEM

The effect of these changes will be far-reaching and will have a tendency to modify, among other things, the school-building program, the school curriculum, the school administration, extracurricular activities, teaching methods, the education of teachers, school financing, federal support, and public relations.

One of the immediate effects of the reduced enrollment is a curtailment of the number of school teachers. There are now forty thousand fewer teachers employed in the United States than there were in 1930. This may imply a lower total of expenditures for education, which at present costs about \$2,500,000,000 yearly.

But a declining school population and the slowing down of the rate of increase of the total population result in many readjustments, and empty classrooms are already being put to new types of educational activities. It is apparent that postgraduate high-school work will undoubtedly be greatly encouraged in consequence, as will graduate work in institutions of higher learning. The five-year high school may become a commonplace shortly. The five-year plan in colleges and universities may presently be inaugurated in most departments and divisions, and no longer be characteristic primarily of the veterinary, medical, and nursing curriculums. Extension courses and adult-education programs will expand considerably. Formerly adult education was confined largely to urban centers. It is now spreading rapidly into the rural areas. A year ago twenty of the

high schools of Michigan offering vocational agriculture conducted evening courses in adult education. This year forty-five of the 233 schools offering vocational agriculture are giving such courses. Yearly more and more teachers are hired to devote part of their time to classes for adults and out-of-school youth.

With declining school enrollment it may be possible that the meager salaries of teachers can be raised sufficiently to attract more male instructors. An increased proportion of male teachers in the grades and in high school should have a wholesome influence, not the least part of which may be the maintenance of reasonable discipline.

If the school budget remains unchanged and school enrollments keep on declining it should be possible to improve the quality of education. Undoubtedly inducements will be made to encourage enrollment and attendance on the part of a larger measure of the potential school population, especially of members of the younger and of the older age groups. Although the proportion of those from five to twenty years of age attending school increased from 45 per cent in 1870 to 73 per cent in 1930, the ideal of having all children of elementary and secondary school age (six to seventeen years inclusive) attend school has not been attained. According to the 1930 United States census, 39.7 per cent of the number not attending were of elementary-school age (six to thirteen inclusive), and 60.3 per cent were of high-school age (fourteen to seventeen inclusive). Furthermore, 17.2 per cent of the children enrolled were absent each day. Better enforcement of existing attendance laws could offset for some years the declining school population. In 1930 in the United States 3,300,000 children from seven to sixteen years old were not attending school. This is several times the expected enrollment decrease during the next decade.

There will probably be a tendency to widen the span of compulsory attendance, which is from seven to sixteen or seventeen years in a majority of the states.<sup>6</sup> If it were extended to eighteen the percentage of children sixteen and seventeen years old attending school (57.3 per cent in 1930) would be materially raised. "It is significant to note that in the five states, Idaho, Nevada, Ohio, Oklahoma, and Utah, in each of which the upper compulsory school attendance age limit with certain exceptions is 18, the percentage of children 16 and

<sup>6</sup> Deffenbaugh, Walter S., and Keesecker, Ward W., *Compulsory School Attendance Laws and Their Administration*, U. S. Off. Ed. Bull., No. 4 (1935) · 12.

17 years of age attending school is much higher than the average for the country"<sup>7</sup> Attempts will undoubtedly be made to lower minimum age restrictions so as to make kindergarten and nursery school possible for more children In 1930 only 20 per cent of the children five years of age were attending school

With lowered enrollments it should be possible to bring about desirable reductions in the size of classes Also, whereas the need for new teachers will be lessened, greater consideration may be given to their selection and training As school services expand into such relatively new fields as vocational, adult, and special education, a new type of instructor will be needed "Teacher-training institutions must also prepare instructors of adults Teachers in the field of adult education, particularly in its civic aspects, should have a unique combination of qualifications, not least among them being some first-hand knowledge of other occupations To provide this type of experience, teachers colleges might well develop and offer programs involving practical community service"<sup>8</sup>

Another immediate effect of the declining enrollment is competition among superintendents for students in the outlying rural districts Already in a score of places school busses invade the school communities of neighboring centers, hauling in pupils to refill vacant seats. Pupils are now frequently being transported from homes beyond the trade areas of the towns in which high schools are located Some of the problems of a school administrator in an era of expanding population will be materially altered in an era of population decline Rivalry for pupils may become as keen as the traditional competition among tradesmen for business In the struggle for survival many of the smaller grade-school districts will be forced to merge with other districts Use of busses in transporting pupils will be stimulated, and school consolidations will continue

The danger of overexpansion in the construction of new buildings is greater than ever Prompt payment of interest and amortization of bonds possible in a period of increasing population may be more difficult in one of stationary or declining population

It is likely that the property tax may become less important as a source of revenue since property values are closely related to pop-

<sup>7</sup> *Ibid.*, p. 2.

<sup>8</sup> *Population Trends and Their Educational Implications*, Res. Bull. Nat. Ed. Assoc., 16 (1935): 42.



ulation density and growth. Residence in many urban areas is shrinking at the center, but is increasing in the suburban regions. Consequently, in some cities, school plants, though numerically adequate, may not be equitably distributed.

#### THE SHIFTING YOUTH-AGE POPULATION RATIO AND ITS EFFECT ON EDUCATION

The growing proportion of persons of economically productive age, twenty to sixty-five years, may tend to lighten the burden of school costs. The birth rate rises or falls inversely with the size of a city and with nearness to a city, consequently, the proportion of youth to age varies considerably for different localities. A declining birth rate automatically tends to decrease the relative number of children and young people and to increase the relative number of elders. In 1880 children under twenty years of age comprised 45.3 per cent of the total population, the proportion had dropped to 38.8 per cent by 1930 and will keep falling, probably to about 26.7 per cent by 1980.<sup>9</sup> It is certain that the ratio of youth to older persons will continue to decrease because it will take years for the full effect of the recent rapid decline in births to manifest itself. Edwards is hopeful that, "as the burden at the elementary school level grows lighter and the rate of increase in high school enrollments falls off, it should be possible to improve standards, to staff the schools with better qualified teachers, to organize more effectively the content of instruction, and to expand opportunities at both junior and senior college levels."<sup>10</sup>

The burden of the adult group, twenty to sixty-four years old, in caring for its dependents of elementary school age, five to thirteen, is over twice as great in some states as in others. For example, California has only 225 such youths for each 1,000 adults, whereas South Carolina has 523. It is in the southern and southeastern states generally that the burden of child nurture and education is especially heavy. Edwards found that a similar imbalance in the distribution of young people appears when the age structure is analyzed by size of community. He says, "Generally, throughout the United States the ratio of children 5 to 13 to adults 20 to 64 increases by sharp steps

<sup>9</sup> Computed from Thompson and Whelpton, *op cit*, p. 107.

<sup>10</sup> Edwards, Newton, "Youth as a Population Element," *Ann Am Acad*, 194. 7 1937.

as the size of the community decreases. In every region and in every state, the urban population carries a relatively light load of youthful dependents." <sup>11</sup> The ratio of youth to adults is considerably higher in rural nonfarm populations than in urban communities. The migration of persons from rural areas to urban areas and from rural states to urban states suggests the importance of increased state and federal participation in financial support of basic educational services, which participation is recommended in the reports of the President's Advisory Committee on Education and is the purpose of bills recently introduced in the National Congress. <sup>12</sup>

The need of federal aid in the support of schools is apparent upon analysis of the varying tax-paying ability in the different states. That school population in the United States is distributed very unequally in relation to income is clearly shown by one of Edwards' analyses. Of the total school population, children five to seventeen years old, 3.6 per cent reside in California, a state receiving 6.6 per cent of the nation's estimated income, whereas 1.9 per cent reside in South Carolina, a state receiving only 0.5 per cent of the national income. <sup>13</sup> He finds, when the states are grouped, that the northeastern ones contain 30 per cent of the entire school population and receive 43 per cent of the nation's income, whereas eleven southeastern states with 24.4 per cent of the nation's school population receive only 10.0 per cent of its income. <sup>14</sup> The gross economic inequalities between rural and urban areas are well known, cities are in a better position to pay for education than are farm areas which have suffered a loss through the migration of their young adults in the prime of their employable years. Farm children five to seventeen years of age comprise 31 per cent of the school population of the country, but farmers receive only 9 per cent of the national income.

Some investigators are much concerned over the prevailing differential birth rates for families on various economic levels. For example, Schorling and McClusky state: "It is estimated that during 1935 half of the babies (87,000) born in the State of Michigan were born in families which were on relief." <sup>15</sup> Of some 2,400,000 births

<sup>11</sup> *Ibid.*, p. 10

<sup>12</sup> Senate Roll 1305 and House Roll 3517

<sup>13</sup> Income estimates as of 1929 are based on Leven, Maurice, Moulton, Harold G., and Warburton, Clark, *America's Capacity to Consume* (1934), p. 13

<sup>14</sup> Edwards, *op. cit.*, p. 14

<sup>15</sup> Schorling, Raleigh, and McClusky, Howard Y., *Education and Social Trends* (1936), p. 85

annually in the United States in recent years approximately 840,000, more than one third, occurred in families which are on relief or which have a total yearly income (including home produce) of less than \$750<sup>16</sup> The true differential between the fertility of the so-called "upper classes" and the so-called "lower classes" may not be so great as the crude birth rates indicate Furthermore, the disparity is probably decreasing, and it may be that within a decade or so the intelligent and better-to-do classes may have the largest families, as is characteristic of natives of parts of Sweden

As has been said, a decreasing percentage of young people automatically means an increasing percentage of elders By 1960 the percentage of people forty, fifty, or sixty years of age, or older, will be much larger than at present Those sixty-five and over, in 1930 numbering six and one-half million, will total about thirteen million by 1960 Present-day youths, therefore, though possibly better qualified socially and educationally than those of any previous generation, enter the modern economic order with little demand existing for their services There has been a continual decline in the employment of children and youth for several decades Among those sixteen years of age the proportion gainfully employed decreased from 40 per cent in 1920 to 25 per cent in 1930 Among the seventeen-year-olds employment decreased during the same decade from 50 to 39 per cent Even fewer eighteen- and nineteen-year-olds were at work for pay in 1930 than had been formerly All these percentages are considerably lower now This condition has been aggravated by the fact that the average duration of human life has been extended by about fourteen years during the last twenty-five years

As a result of this situation the processes of curriculum planning and curriculum reconstruction will continue, with greater emphasis on the foundations for vocational guidance and education and on the enrichment of life through the constructive use of leisure With increased specialization and rapid technological improvements the schools will be called on to give more and more short postgraduate courses to college graduates annually, and special short courses to other persons periodically Enrollment in summer schools will continue to increase In the determination of educational objectives school administrations will be more cognizant of the occupational

<sup>16</sup> *Proceedings of Conference on Better Care for Mothers and Babies*, U. S. Children's Bur., Publ. No. 246 (1938) · 127.

shift from the productive and extractive occupations to the mechanical, professional, and personal-service occupations. With greater and greater specialization the securing of the first job seems to have become increasingly difficult, so that vocational guidance in the secondary schools is more necessary than it has ever been before.

Increasing mobility of the population throws a responsibility upon schools to adopt courses of study, teaching methods, and guidance procedures flexible enough for the migrants. Economic insecurity and rapid transportation and communication have caused educational questions as well as most other social and economic difficulties to become interstate and national problems and have caused citizens of a state to become more than ever before citizens of the nation.

With the enrollment in high schools reaching a peak this year or next some of the problems of teacher-training departments will cease. "The necessity of doubling the number of high school teachers each decade has placed a severe strain on existing teacher-training facilities. Teachers who instruct classes of 30 to 50 pupils during the year may spend their summers in teacher-training classes with 50 to 500 students. All this has, of course, traveled a long way from Mark Hopkins on one end of the log and a boy on the other." <sup>17</sup>

The slowing down of population growth makes more feasible a rising standard of living. It should be possible to satisfy the needs and wants of 155 million people in a democratic state more readily than those of 300 million, and to support six million people in Michigan more easily than twelve million. At the time of the 1930 census 86 per cent of the farm homes in America were without electricity, 84 per cent were without water piped into them, 80 per cent were without radios, 64 per cent without telephones, and 42 per cent without automobiles. Rapid increase in population did not make possible to the masses the acquisition of these facilities, slower population growth, by encouraging lower prices, may do so.

Smaller families, characteristic of a diminished population, will cause education to place greater emphasis on the family. More courses dealing with it and its problems will be offered. The intrinsic values of domestic life will receive more stress; the sound and common-sense interpretation of the function of the home will probably

<sup>17</sup> "The Problems of a Changing Population," in *Report of the Committee on Population Problems to the National Resources Committee* (1938), p. 199.

also serve in part as a counterbalance to eccentric proposals to tax bachelors, to award bonuses for twins and triplets, and to make payments of "thirty dollars every Thursday" to "senior citizens." Parents with but one, two, or three children are likely to become more interested in those children and in juvenile schooling, so that the home and the school, through parent-teacher associations, child-study groups, and the like, will cooperate with each other more

Schools and families of the past may be compared to mass-production industries, where numerical output and regimentation, rather than respect for individual differences, are prime considerations. In an era of static population and of greatly reduced school enrollment the wholesome well-integrated personality may become a basic objective of formal and informal education.

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